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INSTRUCTIONS FOR MOUNTING USING, AND CARING FOR

DISAPPEARING CARRIAGE

L. F., MODEL OF 1897

FOR

12-INCH GUN

MODEL OF 1895

(*THIRTEEN PLATES*)

REVISED MAY 31, 1904
REVISED NOVEMBER 26, 1909

WASHINGTON
GOVERNMENT PRINTING OFFICE
1917

UF650
V.6
12 in.
1897

LIST OF PLATES.

Drawing No.

I. Platform (emplacement) 10–9–25
II. Longitudinal section (movement) 10–9–1
III. Plans and elevations (carriages 1 to 35, except 6, 7, 9, 10, 11, 12, 16, 17, 19, 20, and 23) 10–9–69
IV. Plans and elevations (carriages 6, 7, 10, 11, 12, 16, 19, 20, and 23) 10–9–70
V. Plans and elevations (carriages 9 and 17) 10–9–68
VI. End elevations 10–9–3
VII. Method of controlling energy of recoil 15–0–1
VIII. Wiring diagram (carriages 1 to 35, except 6, 7, 9, 10, 11, 12, 16, 17, 19, 20, and 23) 14–6–40
IX. Wiring diagram (carriages 6, 11, 16, and 20. Similar wiring on 23 also). 14–6–84
X. Wiring diagram (carriages 7, 10, 12, and 19) 14–6–38
XI. Wiring diagram for carriages 9 and 17 14–6–37
XII. Electrical elevating and retracting system, carriages 9 and 17 14–6–60
XIII. Electrical traversing system, carriages 9 and 17 14–6–61

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INSTRUCTIONS FOR MOUNTING, USING, AND CARING FOR DISAPPEARING CARRIAGE, L. F., MODEL OF 1897, FOR 12-INCH GUN, MODEL OF 1895.

(Thirteen plates.)

Note.—All 12-inch disappearing carriages, L. F., model of 1897, will be provided at an early date with electric retracting mechanism, sighting platforms, 3-inch objective telescopic sight, counterbalance device, etc., which will make these carriages similar to the 12-inch disappearing carriage, L. F., model of 1901, after number eleven.

(The points in *italics* are of importance, or concern the safety of the carriage, and should be specially noted.)

GENERAL DESCRIPTION.

The Emplacement (Pl. I).—Emplacements for these carriages are entirely of concrete and can be arranged for a maximum field of fire of 170 degrees. The general arrangement of loading platform, with a circle of five steps down to the working platform, a concentric depression for the turntable, and a counterweight well, is adhered to; but the form of the loading platform and other arrangements are modified by the position.

The Carriage (Pls. II, III, IV, V, and VI).—This carriage is designed to mount the Model of 1895 Gun, but a few elevating bands have been made for the Model of 1888 Guns, none of which, however, has yet been mounted.

The principal improvements on the previous model are: Less height of carriage above racer, and working platform around racer at same height; racer joints on the sides; transoms inserted near the front and rear of chassis; live recoil rollers; counterweight suspended under crosshead by four rods, and screw elevating gear.

The carriage is now to be supplied with electric motors for retracting only; connections for electric firing by the man at the sight; the addition of safety appliances for both electric and lanyard fire, the latter preventing firing before the gun is in battery; improved lubricating appliances; new counter recoil buffers, which permit of sufficient counterweight being used to decrease the time of going into battery.

Stops can be so arranged as to permit traversing either 60, 70, 90, or 110 degrees either side of the "front" of the battery, and the piece can be elevated from 5 degrees depression to 10 degrees elevation, stops being arranged to limit the depression to either horizontal or 2.5 degrees depression when the height of the parapet requires it.

When in the execution of mechanical maneuvers it may become necessary to traverse the piece breech to the front, which can be done with gun in battery, the stops must be removed and care exercised that the electric cable in the pit is not injured by traversing the counterweight against it.

The elevating system is so constructed that the gun is at an angle of about 4 degrees elevation when in the loading position, if recoiling to the thirty-third notch, with any angle of elevation in battery.

Action of Carriage.—Upon firing the piece the gun-lever axle is moved to the rear by the recoiling energy of the gun, carrying the top carriage with it. The lower ends of the levers move vertically upward, being constrained by the crosshead traveling on the vertical crosshead guides. The trunnions of the gun move downward and to the rear in the arc of an ellipse. The energy of recoil is absorbed partly by raising the counterweight and partly by the movement of the masses up the inclined chassis rails, but principally by the resistance of the recoil cylinders; and when the gun comes to rest it has the proper loading angle. After loading, the pawls are tripped, and the excess of the moment of the counterweight over the moment of the gun, etc., enables it to raise the gun to the firing position. If this excess be small, the velocity of counter recoil will be slow; but if more counterweight be added, the velocity will increase and the time required for going into battery will decrease.

Principal Parts.—The carriage consists of the following principal parts, viz: Base ring, azimuth circle and pointer, traversing-roller system, racer, clips and dust guards, chassis and transoms, top carriage and recoil rollers, recoil and counter-recoil system, gun levers, crosshead, tripping gear, counterweight, elevating arm, band and slide, elevation and range scales and pointers, elevating, traversing and retracting systems, working platform, sighting platforms and ladders, sight standard and telescope sights, lanyard safety attachment, electric safety firing attachments, electric motor equipment retracting the gun; accessories, including ammunition trucks, shot tongs, and implements.

Base Ring.—The base ring, 19 feet in diameter, is made of cast iron, in halves, bolted and keyed together, and is held in position on the foundation by 26 2.5-inch bolts. Leveling wedges are provided, and require occasional inspection to see that they do not become loose. They are also used to relevel the carriage in case the platform settles out of level. The base ring, in addition to having the lower roller path formed on its upper surface, has an annular flange near its inner edge, forming the pintle for the carriage. This flange has near its top edge a lip inward, under which the clips engage, and on its top edge the azimuth circle.

Tapped holes can be found inside of the pintle flange for attaching the traversing stops in any required position.

The base ring is stamped "front" on the top surface between bolt holes.

AZIMUTH CIRCLE AND POINTER.—A brass azimuth circle, attached by countersunk screws to the top of the pintle of the base ring, is graduated in degrees, the numbers of which are to be added after the carriage is erected in its emplacement. The top of the racer is cut away on the left side to expose the azimuth circle, in smooth contact with which is an azimuth pointer having a subscale. The pointer has slotted holes to give it a lateral motion for adjustment, after which it is fixed in position by two dowels. The least reading is 0.05 of a degree. In later carriages of this model a micrometer pointer and subscale is provided, by which the azimuth may be read to 0.01 of a degree. The whole is protected by a bronze hinge cover.

TRAVERSING ROLLER SYSTEM.—The racer rests and is traversed upon a circle of 24 live, conical, traversing rollers, whose axes are maintained in the radial position by forged-steel axles, which are framed in wrought-iron distance rings. The distance rings are united by 22 cast-iron separators. The rollers are of forged steel, 9 inches in diameter at the small end, and are bushed with bronze. The system is kept concentric with the pintle by the flanges on the rollers in centrifugal contact with the inner edge of the roller paths.

RACER.—The racer is made of steel, 17.75 feet in diameter, and cast in halves, bolted and keyed together with the joints on the side of the carriage. In the later carriages observation holes have been provided on each side of the carriage, covered with plates, to facilitate oiling, inspection, and cleaning of rollers and roller paths. In addition to having its upper roller path on its under surface, it has an annular flange lined with bronze near its inner edge, and fitting over the pintle with 0.04-inch diametral clearance.

Upon its top surface the chassis and transoms are bolted, doweled, and keyed, and on its outer flange the working platform brackets are bolted to pads.

Two oil holes on each side near the chassis, with connecting grooves, provide means for oiling the pintle surface.

CLIPS AND DUST GUARDS.—The lower part of the front transom engages under the lip on the inside of the pintle flange, thus forming the front clip, and also the moving lug which strikes the stops, limiting the traversing movement. The rear clip is formed by the lower part of the guide bracket of the counterbalance device.

There is a dust guard outside of the roller-ring system, formed in four sections of wrought iron and bolted to the base ring. This should be occasionally removed to inspect and clean the rollers and roller paths. Felt and steel pinching strips are to be added to the upper inside edge of the dust guard.

CHASSIS AND TRANSOMS.—The chassis of cast iron are bolted, doweled, and keyed to the racer and are united at their front and rear ends by cast-steel transoms, also bolted to the racer. The rear transom carries the elevating slide and gearing. The upper surfaces of the chassis form the recoil-roller path and slope 1 degree and 20 minutes to the front to facilitate the return of the piece to the firing position, thus reducing the necessary preponderance of the counterweight.

The chassis also provide the necessary bearings or supports for all the mechanism, and with the racer supports for all the minor attachments.

The crosshead guides are machined flush on the inside and near the front end. They extend from below the racer to above the top of the piston-rod lugs.

Stops are machined in rear of the lugs against which the top carriage and recoil rollers come to rest when entirely in battery.

TOP CARRIAGE AND RECOIL ROLLERS.—The top carriage, which is similar to that of an ordinary barbette carriage, is made of steel cast in one piece. It consists of two side frames containing the beds for the gun-lever axles, and two recoil cylinders, all united by a transom. It rests upon two sets of 13 live recoil rollers which are bushed with bronze and run on steel axles set into movable steel cages. The rollers are of forged steel, and flanged on both ends to guide the top carriage upon the chassis. They move to the rear with the top carriage at half its speed and travel half as far.

Lugs project from the lower front part of the top carriage, which serve as fulcra for pinching bars held horizontally and engaging with teeth cast on the chassis rails, by which arrangement the top carriage may be removed forward to the firing position against the stops if from any cause it should fail to come fully into battery. When time permits, the top carriage should always be brought fully into battery (against the stops); but, if desired, the gun may be fired when the top carriage is as much as 3 inches out of battery with perfect safety and with no bad results other than inaccuracy in the elevation of the gun, unless its elevation be given by telescope sight on gun trunnion or by quadrant on the gun.

Clips projecting from the lower rear part of the top carriage engage under flanges on the top of the chassis to prevent the carriage from tipping forward upon striking the stops in returning to the firing position.

The axle beds in the side frames are provided with caps, clipped on and secured from lifting off by four studs each, having nuts and check nuts. The caps and beds are lined with bronze half bushings.

RECOIL AND COUNTER-RECOIL SYSTEM (Pl. VII).—This plate shows the general arrangement of the hydraulic brake and its connections in its essential principles and in relative positions of parts for disappearing carriages "in battery."

The recoil cylinders are lined with cast iron and are 13 inches in interior diameter, with piston rods 4.75 inches in diameter having pistons and counter-recoil buffer plungers solid with them. The rods are secured by nuts and check nuts to upright lugs on the chassis, and, extending through the rear cylinder heads, their rear ends are supported by brackets bolted to the chassis.

At the ends of the cylinders there are the usual stuffing boxes with glands and followers.

The counter-recoil buffers are formed by bronze bushed annular projections on the rear cylinder heads which fit into the cylinder and are supported by its walls. In the recesses thus formed fit tapering plungers on the piston rods. When the gun returns to the firing position the liquid caught in the recesses in the cylinder heads can escape only through the small clearance between the plunger and the walls of the recess, thus acting as a hydraulic buffer or dashpot to check the velocity at the end of the return into battery. At the front end of the chassis rails counter-recoil stops are provided to prevent the bottoming of the buffer plungers in the annular recesses. Against these stops the top carriage abuts when in the firing position.

Each cylinder has one filling hole near its front lower end.

That portion of the cylinders above the level of the filling holes (about 300 cubic inches in each cylinder) is intended to be empty, this being for the purpose of allowing the oil sufficient space in which to expand when heated by weather or the friction developed in firing, and to provide a space into which the plunger of the counter-recoil buffer may be withdrawn. This withdrawal is accomplished so rapidly in recoil that the oil can not flow through the small clearances and fill the seat of the buffer without the development of a very high pressure in the cylinder, which would be undesirable.

To secure equal resistance and equal fluid pressure in the two cylinders an equalizing pipe connects their front or pressure ends. In this pipe is an emptying coupling by which the whole recoil system can be emptied of oil. From this coupling a connecting pipe extends back to the throttling valve, and from this valve pipes connect with the rear ends of the cylinders.

Bronze plugs are provided, to be screwed into the cylinders in place of the equalizing and throttling pipes, thus continuing the piece in action should the pipes be destroyed.

During the recoil the pistons remain stationary and the top carriage, with its cylinders, is drawn over them.

Each piston is slotted through its opposite sides, and two throttling bars lie in the slots and are bolted the whole length of each cylinder. Their sectional area is such that the orifices for the flow of the liquid vary with the position of the piston during recoil so as to attain the desired resistance in the cylinders.

In any hydraulic brake the resistance is greater as the velocity of the piston in the cylinder is greater and as the openings for the passage of the liquid are less. The velocity of retarded recoil of the top carriage being variable and a constant resistance being desired, the orifices are usually varied in such manner that the relation between the velocity and the area of the orifices is at all points such as to give a nearly constant resistance.

Uniform resistance to the motion of the top carriage is obtained, its motion retarded and finally stopped, and the energy of recoil taken up, principally by the resistance which the oil in the cylinders offers to being forced from one side of the piston to the other through the following openings:

1. The clearance between the walls of the cylinder and the piston, necessary for working movement. This opening is of constant area.
2. The orifices between the throttling bars and their slots in the piston. These openings vary with the profile of the throttling bars, since the slots, which are partly closed by these bars, are of constant area.
3. The opening of the throttling valve which controls the flow through the pipes connecting the front and rear ends of the cylinders. This opening is of constant area during recoil, but can be completely closed or changed to suit different conditions of loading and to correct for any other conditions that would cause a variation in the length of recoil.

The two throttling bars in each cylinder are constructed of constant width, with only a sufficient lateral clearance in the slots for working movement, and of varying depth, the profile being so designed that the area of the orifices (the portions of the slots not filled by the bars) for the escape of the oil past the piston increases from the beginning of motion up to the point where the velocity of retarded recoil of the top carriage is greatest; beyond this point the velocity of retarded recoil of the top carriage is continually decreasing, and the area of the orifices decreases also, until it becomes zero at the end of recoil. The orifices have at each point of recoil such a relation to the velocity of retarded recoil of the top carriage at that point as to give nearly a constant resistance to the motion of the top carriage. This results in a nearly constant fluid pressure in the cylinders.

The areas of the orifices have to be calculated for a particular set of conditions of loading, and any variation in these conditions will change the length of recoil of the top carriage, and consequently the height and inclination of the breech of the gun in the recoil position. As the standard conditions of loading do not always exist, it has been found desirable to provide means for varying the resistance of the hydraulic recoil brake in order that the prescribed length of recoil (bringing the gun into the prescribed loading position) may be obtained under any conditions, standard or not standard—as, for example, when practice charges are fired.

For this purpose the equalizing pipes between the front ends of the cylinders are connected with the throttling pipes between their rear ends through the emptying coupling and a *throttling valve,* providing oil passages from the front, or pressure, to the rear side of the pistons, which can be completely closed or changed in area.

This throttling valve can be adjusted to give openings varying by 0.025 square inch from 0 to 0.55 square inch. The graduations of the valve are stamped on the top of the body, there being 11 divisions, numbered 0, 0.5, 0.10, etc. *One complete turn of the valve effects a change of 0.05 square inch in the opening. One-half turn effects a change of 0.025 square inch.* One complete turn of the valve yoke generally changes the length of recoil by the equivalent of three or four notches on the crosshead rack. This is liable to vary by a notch or more for different carriages, or for the same carriages under different conditions.

The setting of the valve best suited to different conditions of loading, full or practice charges, etc., can be determined only by experience in actual firings with each particular carriage. Different carriages may require different settings, and the same carriage may even at different times require different settings for the same conditions of loading if it is in a materially different condition as to cleanness and lubrication of the working parts, etc. It is necessary, therefore, that careful records be kept, not only of the setting of the valve, the conditions of loading and recoil, but also of the elevation of the piece and any abnormal condition of the carriage which might affect the freedom of its operation. These records should be studied in the light of all these circumstances to obtain perfect working. However, the ammunition trucks are so designed that the loading position may vary somewhat without material inconvenience, and it is generally possible after a few firings with a carriage to determine the settings of the valve which will result in the gun coming into a proper loading position for any conditions of loading. *For full charges the valve should, in the lack of experience with the particular carriage, be opened to about 0.15 square inch, but not more.*

A padlock is provided for locking the valve yoke in any position to guard against accidental or unauthorized changes in the position of the valve after it has been set. The valve should habitually be kept locked, but this should not be understood as discouraging examination and manipulation of the valve, which are, on the contrary, highly desirable for the sake of familiarizing the personnel with its construction and operation.

For all charges the cylinders should be filled to the level of the filling holes, removing for this purpose both plugs, so as to permit the air to escape.

A neutral oil, of specific gravity about 0.85 (such as the "hydroline" at present issued), is used, and with this oil the working pressure in the cylinders is about 1,000 pounds per square inch. A denser oil would cause a higher pressure in the cylinders and therefore shorten the recoil slightly.

For the purpose of reducing the shock of accidental excessive recoil, recoil buffers, made up of alternate layers of balata and steel plates, are placed on brackets bolted to the rear of the chassis, where they will be struck by the upper ends of the gun levers if the gun is retracted or recoils beyond its proper position.

The notches between the ratchet teeth cut on the front faces of the crosshead clips are numbered from the top, the numbers being opposite the notches on brass strips screwed to the crosshead. When the top pawl teeth, indicated by brass arrows screwed to the pawl levers, engage in the thirty-third notch, the gun is in its calculated loading position, *below which it should not be retracted.* By a proper adjustment of the throttling valve the recoil of the gun should not vary much from this position. The ammunition truck will, however, permit the gun to be loaded anywhere between its position when the pawls engage in the twentieth notch and the lowest possible position—gun levers on the balata counter-recoil buffers.

In case the gun recoils far enough for the pawls to engage, but not sufficiently for loading, it may be brought down by the use of the retracting gear.

From the foregoing description of the recoil system it should be evident that should the carriage recoil too freely the proper correction is in a diminution of the opening of the throttling valve, not in an increase of the counterweight. On the other hand, the counterweight alone should be changed to correct or modify the counter recoil.

The amount of counterweight can be determined by trial. However much of the counterweight furnished be used, it will not materially affect the length of recoil.

On account of the efficient counter-recoil buffers considerably more counterweight (3,000 or 4,000 pounds or more) can be employed in this carriage than is necessary to bring the gun to the firing position without injury to the buffer or cylinders or injurious shock to any part of the carriage. This extra counterweight acts to accelerate the counter recoil, and thus the time of going into battery completely is reduced to from five and one-half to seven seconds from the instant of tripping.

GUN LEVERS.—These two levers are made of cast steel, connected near their upper ends by a cast-steel yoke firmly bolted and at a point a little below their middle by the forged-steel gun-lever axle, which is fastened to the levers by bolts passing through its heavy flanges. The gun levers are supported by this axle, the projecting ends of which serve as trunnions supported by and rotating in the axle beds in the top carriage. The upper arms of the levers support the gun, and from their lower ends the counterweight is suspended by crosshead pins.

The trunnion beds are provided with cap squares clipped on and secured from lifting off by two studs, each having nuts and check nuts. The caps and beds are lined with bronze half bushings.

CROSSHEAD.—The crosshead, of cast steel, is connected by pins to the gun levers, and from it the counterweight is suspended by four keyed rods.

Clips formed in one piece with the crosshead are lined with bronze and engage over crosshead guides cast on the inside of the chassis rails. These guides constrain the crosshead to move in a vertical direction.

Ratchet teeth are cut on the front faces of the clips, to be caught by pawls pivoted to the chassis rails, and in this way the counterweight is held up and the gun is prevented from returning to the firing position after recoiling.

TRIPPING GEAR.—After the gun is loaded it is permitted to rise to the firing position by raising the tripping levers until they are latched and immediately leaving them in that position.

The action is entirely automatic after the pawls are latched out of engagement and the gun starts into battery. After the crosshead teeth have passed entirely below the pawl teeth and the gun is nearly in battery the pawl levers are released from the latches by the automatic action of dogs on the crosshead and are returned by the movement of the weight of the tripping levers, etc., to their proper positions ready to engage the crosshead when it again rises.

The pawls may be tripped by the use of one or both levers. The levers should not be raised while the gun is in battery, but should the pawls become latched out of engagement at this time, the rising of the crosshead will again release them ready for engagement.

COUNTERWEIGHT, BOTTOM PLATES, AND SUSPENSION RODS.—The bottom plate of cast steel and the four rods which suspend it from the crosshead form the cage which carries the lead counterweight. The counterweight is piled in the cage in layers of different thicknesses, each layer consisting of two or more pieces. There are 72 smaller pieces on top, provided with rings for easy handling. These weigh in all about 5,939 pounds. By adding or removing some or all of these smaller weights the counterweight can be readily increased or diminished. The total amount of lead counterweight furnished is 98 pieces, weighing approximately 138,635 pounds, and forming a pile, including bottom of cage, 7 feet 8.5 inches high.

Carriages Nos. 1 to 12, inclusive, have special form of counterweight 3.5 inches shallower than the regular model. Layers 2 to 8, inclusive, weigh 70,310 pounds, and two special weights form the tenth layer. These weigh 7,657 pounds. There are but 60 detachable lead weights, 4,979 pounds, forming an eleventh layer. The 12 carriages of special design have a counterweight, therefore, weighing (lead) 139,444 pounds; total, 155,630 pounds. Nos. 1 to 5, inclusive, have a special form of key for connecting the suspension rods to the counterweight bottom and also to the crosshead.

The amount of lead counterweight sent with each carriage is designed to be 3,000 or 4,000 pounds *in excess of that required to raise the gun to the firing position* under normal conditions. No matter what charge be used the counterweight used should be such as will raise the gun completely to the firing position in about seven seconds, but should never be such as to cause the top carriage to strike the counter-recoil stops with great shock. In its lowest position the counterweight hangs in a well formed in the concrete platform concentric with the base ring 12 feet 6 inches in diameter and not less than 78.5 inches in depth, measured from the underside of the base ring. Access to the bottom of the pit is obtained by means of a ladder and a manhole in the right inside platform.

ELEVATING ARM, BAND, AND SLIDE.—The elevating arm of cast steel carries a fixed double-ended pin at its lower end, rotating in bearings in the elevating slide, and has two solid-bronze bushed bearings at its upper end for the elevating-band trunnions.

The band is of cast steel, with inserted trunnions screwed to their conical seats and with tit set screws through them which enter shallow holes in the gun at accurate distance from the trunnions on each side and in the same horizontal plane with them. The band is tightly clamped around the gun by two heavy bolts. Their inside diameters are for the gun of the model of 1888, 46.2 inches, and that for model of 1895, 44.5 inches.

The elevating slide is moved by the elevating gearing system, in an inclined guideway machined on the rear face of the rear transom, which guideway allows it the movement necessary to change the elevation of the gun from 5 degrees depression to 10 degrees elevation.

There is provided a removable stop, to be placed in holes in the right side of the guideway and above the slide, limiting the depression to either 0 or 2.5 degrees, as may be required by the parapet over which the gun is to be fired.

While theory requires, in order that the gun when recoiled to the thirty-third notch shall always return to the same angle for loading, with the breech at the same height, whatever may be the firing angle, that the elevating slide and its guideway shall be circular and struck with radii, using the center of the trunnion on the elevating band, when the gun is in the loading position, as a center, yet the expenses of manufacture have made it desirable to make the slide and guideway straight. These are so placed, however, as to cause only a slight variation in the height of the breech and in the loading angle.

ELEVATION DISK AND POINTER.—The elevation disk consists of a circular wheel carrying the graduated elevation and subcaliber and service range scales at its outer circumference and mounted upon a shaft which has keyed to its inner end a pinion engaging in a rack bolted to the elevating slide. The up-and-down motion of this rack rotates the pinion and shaft and the circular wheel carrying the scales. A spiral spring takes up backlash in the gear teeth. The elevation scale is graduated in 5 degree spaces, the relations of the parts of the elevating mechanism being such that the successive 5-degree spaces are not of the same length of arc. This requires the scale to be graduated with the gun mounted upon the carriage and by the use of a clinometer supported by a rest placed in the muzzle. This is usually done at the time of the shop test.

As the ranges corresponding to different angles of elevation above the horizontal depend upon the height at which the gun is mounted above the sea level, the range scales must be graduated after mounting. The range graduations must be calculated for each gun with due regard to the height above sea level and the normal muzzle velocity. These graduations should then be marked upon the scale in the proper place *under the supervision of the Ordnance Department.*

The pointers provide flush zero marks for each scale and are arranged for adjustment in arc, which may be necessary for a particular field of fire if the emplacement settles unevenly. The pointer piece is bolted and doweled to a bracket bolted to the chassis. Adjustment requires the use of the clinometer as described above.

ELEVATING SYSTEM.—Two handwheels are attached to the ends of the elevating shaft, to be manipulated by two men standing on the working platform, one at each wheel. These wheels actuate through a train of bevel and spur gearing, a forged-steel elevating screw operating the bronze elevating-slide nut. This slide nut actuates the elevating slide, to which the lower end of the elevating arm is pivoted, through the medium of two helical springs, interposed to relieve the arm from shock due to the downward thrust when firing with the gun elevated.

Upon this carriage no separate spring buffer stops are provided, as the buffer springs between the slide and nut fulfill the requirements. At the limit of depression of the gun the slide strikes a positive stop and the nut is stopped by the spring; at the limit of elevation the nut strikes a positive stop and the slide is stopped by the spring.

The carriages are to be altered so that the elevating screw may also be actuated by a slow-motion elevating handwheel adjacent to the elevation disk on the left side of the carriage through two pairs of bevel gears and two shafts. A clutch is to be provided for engaging or disengaging the slow-motion gearing at will.

COUNTERBALANCE DEVICE.—This device tends to equalize the force required for elevating and for depressing the gun in the loading as well as in the firing position. It consists of a cast-iron weight hung by a double wire rope which passes over sheaves and is attached to the elevating-slide nut, so as to oppose and partially counterbalance the weight of the slide and one-half the weight of the elevating arm. The use of too much balance weight will result in an upward thrust on the elevating screw, conducing to serious wear on the underside of the screw bearing.

TRAVERSING SYSTEM.—For pointing in azimuth by hand power two crank handles may be attached to the traversing shaft and manipulated by two men standing on the working platform, one at each crank. From this shaft motion is transmitted by two pairs of bevel gears to the vertical shaft in bearings on chassis and racer, the pinion at the lower end of which engages in the circular traversing rack bolted to the base ring and by its rotation causes the racer and all parts carried thereon to rotate upon the rollers and around the pintle surface.

Carriages Nos. 1, 2, and 3 differ in having a balance traversing gear.

While the construction of the carriage itself permits it to be traversed 360 degrees, stops are provided which are to be screwed to the inside of the pintle above the traversing rack, limiting the movement in azimuth as may be required by the emplacement in which the gun is mounted.

To prevent excessive shocks to the traversing gearing or other parts, due to striking obstructions or to too sudden application of power, etc., in a few carriages formerly fitted with electric power for traversing, the intermediate bevel gear is not keyed to the shaft, but centered upon and held frictionally by three disks, free to move longitudinally on two feathers made solid on the pinion shaft, and pinched between a solid collar above and an adjusting nut below.

The nut is locked by being jacked apart with a set screw at a cut which extends partly across.

The friction surfaces are provided with oil grooves which, together with the spaces between the disks, are to be *kept filled full* with oil through a hole in the top end of the shaft.

The adjusting nut should be set up just enough to rotate the carriage by hand without slipping. It was intended that in rotating by power suddenly applied the disks shall slip at first and thus pick up the load gradually.

The carriages are to be provided with a slow motion traversing gear with a handwheel adjacent to the telescope sight on the sighting platform.

The electric traversing attachments have been ordered removed from all carriages of this type in service.

RETRACTING SYSTEM.—For hauling the gun down by hand two removable crank handles may be attached to the retracting crank shaft and maneuvered by 8 men standing on the working platform, 4 working on each crank. The retracting crank shaft actuates through a train of three pairs of spur gearing, two drums, to which are fastened by corrugated clamps two wire ropes, which wind upon the drums. A ratchet and pawl prevents the load from overhauling the gearing.

From the drums these ropes pass around guide pulleys in rear of the recoil buffers and are hooked to the upper ends of the gun levers. These ropes remain with the carriage, and when not in use are wound upon the drums until the ropes project but a short distance from the guide-pulley brackets.

For rapid and easy overhauling of the ropes two small speed cranks are fixed to the crank shaft back of crank handles. To save time these should also be used to wind up the slack of the rope before placing the crank handles on the shaft. In hauling down care should be exercised that each rope is under *equal tension.*

After taking up the slack in the ropes and putting some strain on them they should be vibrated slightly, and if found to be unequally loaded adjustment should be made at the rope clamps on the drums. After the loop of the rope is placed over the hook on the gun levers, and while winding up the slack, especial care should be taken that the rope is guided to the pulleys without any kinks or any slack and that the coils lie smoothly upon the drums without crossing the ridges between the grooves.

The wire rope should always be detached from the gun-lever hooks before tripping.

RETRACTING GEAR CLUTCH AND BRAKE.—To permit the most rapid overhauling of the wire ropes possible, there has been added a spring-engaging claw clutch for rotating the drum shaft, from the drum gear, in retracting. With the clutch thrown off, the ropes can be drawn out quickly, revolving the drums and shaft rapidly in the drum gear.

In order to prevent overrunning and injury to the ropes a band brake is added, gripping the hub of the left drum, upon lifting a crank handle. The clutch is thrown off by drawing a loop handle on the left side until the feathers are drawn out and permit the handle to be given a quarter turn, which locks the clutch off with the spring compressed.

When enough rope is overhauled the brake handle is raised to stop the shaft, the loop is given a quarter turn back to permit the feathers to enter, and the spring moves the clutch on its feathers in the drum shaft to engagement.

Working Platform.—The outside platform of plates and angles is flush with top of racer, is supported on radial cast-steel brackets bolted to it, and covers the recess around the turntable, flush with the fixed part of the platform.

The inside platforms, supported by the racer and chassis, cover the sides of the counterweight well. On the right side a manhole and ladder is provided for entering the well.

Sighting Standards and Platforms.—These platforms of plates and angles extend along each side of the carriage, supported in front by brackets bolted to the top of the crosshead guides on the chassis and in rear by standards bolted to the racer and chassis. The brackets and standards are of steel castings.

A flight of steps is provided at the front and rear end of each platform. Hand rails and a screen to protect the gunner's body from the elevating arm during recoil of the piece are also provided. These platforms furnish not only a station for sighting and pointing and firing, but also a convenient means of access to the gun, retracting hooks, trunnion beds, etc., for oiling or other purposes, e. g., for inserting a new primer.

Sight Standard.—This standard is a steel casting seated and clamped in a split socket in the top of the left standard. It extends forward as a bracket, forming a pivot and guide for the sight arm which carries the telescopic sights.

Counter set screws are provided at the socket for making a slight adjustment in rotation and fixing the standard, with the line of collimation of the telescope and open sights in a vertical plane, parallel to a vertical plane through the axis of gun.

To this standard is attached the firing pistol.

The sights provided for these carriages are the 3-inch telescopic sights, model of 1904.

Firing Apparatus.—The gun may be fired either electrically or by lanyard. The current for firing electrically is obtained from a battery of dry cells placed in a box supported in a bracket attached inside the left chassis. One wire leads, through the safety-firing switch, to the "ground" near the breech of the gun; the other through the switch and pistol to the primer. Both wires lead up the left gun lever and are incased in flexible metallic tubing for protection.

The gun can be fired by closing the circuit at the pistol only after the circuit has been closed for both wires at the switch.

The pistol case incloses not only the contacts brought together by the trigger when pulled, but also a buzzer, which enables the gunner to determine whether the circuit is complete for firing. By pressing the button over the pistol handle a circuit is completed through a resistance coil, which permits just enough current to pass to sound the buzzer but not enough to explode the primer, *if kept on for an instant only.* The ear should be held close to the buzzer to detect the sound. Pulling the trigger cuts out the resistance and completes a direct circuit, permitting the passage of sufficient current to fire the gun.

The switch is essentially double-pole and single-throw, the blades being pivoted on the chassis and the double clips attached to the top carriage. When the top carriage is within 2.5 inches of the stops "in battery" the clips are directly above the blades and contact may be made by raising the latter. The corrugation and bead of clips and blades will retain them in contact until the top carriage moves to the rear, when the blades will drop. It is thus impossible to fire when the top carriage is more than 2.5 inches "out of battery."

A circuit breaker on the breech of the gun, which is opened by the first movement of the block to open breech, also renders it impossible to fire, except when the breechblock is fully closed.

The gun is fired by lanyard from the loading platform. A lanyard attachment is so arranged as to prevent firing, from a pull upon the lanyard, before the gun has been raised to such a height that the projectile will clear the parapet.

It consists of an incased reel, attached to the elevating band, upon which a short cable is automatically wound by a spiral spring, and locked, except when the piece is "in battery," by a ratchet and pawl. One end of a short lanyard is hooked to the firing mechanism and the other to the end of this cable. The long lanyard in the hands of the cannoneer is also hooked to this cable. When the gun rises in battery, a cam on the elevating arm passing under the pawl lifts it out of engagement with the reel, which can then be unwound by a pull on the long lanyard which in turn pulls the short lanyard to fire the primer.

The initial tension of spring should be sufficient only to wind up the cable with lanyard attached. It may be adjusted by loosening the nut on the shaft, and with wrench on its squared end (projecting from the center of the case) withdraw the locking pin and wind up or unwind the spring, returning the locking pin to one of the quarter-turn positions and tightening the nut.

A device on the firing mechanism renders it impossible to fire the primer by a lanyard pull except when the breechlock is fully closed.

Electrical Equipment (Pl. VIII).—All of these carriages are to be equipped with one motor and gearing for retracting only.

The motor is supported by a cast-steel bracket bolted to the inner side of the left chassis.

The shaft extends through a bearing in the opening in the chassis, and in an improved design is supported at its outer end by a bracket bearing. A cast-steel maneuvering lever is arranged to oscillate on the motor shaft and to carry an idler gear on a fixed pin and in mesh with the motor pinion between its branches. The top end of the lever is guided in and may be pinned in three different positions to an arc attached to the chassis over the motor shaft.

With the lever in the forward position the idler is in mesh with the gear on the retracting crank shaft, and with the lever in the mid position the idler is free from this gear and the motor armature will not be revolved by retracting by hand.

The lever should never be left unpinned, and should never be shifted when the motor or any part of the gearing is in motion. Care should be taken in shifting that the teeth of the idler are opposite spaces in the gears.

The motor is of the completely inclosed type. It has a shunt-wound field and is capable of delivering 8 horsepower, at 625 revolutions per minute, for a period of one hour.

A starting rheostat with a no-voltage release is supplied for starting, stopping, and controlling the motor, and is attached to the left chassis in rear of and above the elevating handwheel.

The rheostat, a double-pole line switch, and fuzes of about 80 amperes capacity are inclosed in a metal box to protect them from injury.

] Experimental Electric Equipment (Pl. IX for motors and controllers only; Pl. VIII for other wiring).—Carriages 6, 11, 16, and 20 have at present the experimental equipment for traversing, elevating, depressing, and retracting. Carriage 23 has essentially similar equipment.

These outfits consist of the following apparatus:

Traversing motor, CB–15, A–11, rated at 4 horsepower and having a speed of about 635 revolutions. This motor weighs about 650 pounds and has a short shaft.

Motor for elevating, depressing, and retracting have the same capacity and rating as the traversing motor. These motors are shunt-wound, the fields being energized directly from the switchboard, the armatures being controlled each by its own controller.

Motor-generator set, consisting of two 3-horsepower motors mounted upon a common bedplate and directly connected to each other, and so connected to the line and controlling apparatus that variable voltage can be obtained for giving accurate control of the speed of the traversing motor. The motor-generator set is the size marked CE–2–3 HP M. S. (moderate speed). This set will be mounted in the power station.

The switchboard contains the necessary instruments and switches for connection with controlling appliances of the various motors. This switchboard will be installed in the power station in a protected location. The system of connections is shown on same drawings, and the arrangement is as follows:

At the top of the board is a single-pole circuit breaker for the motor-generator set. The circuit breakers for the elevating and traversing motors are in a closed metallic case on the carriage for ready reclosing. These circuit breakers have scales so that they can be set to open at any desired current within their limits. They should be set a little higher than the rating of the motors which they protect. At the left of the switchboard, on swinging bracket, is a voltmeter showing the potential of the line, and underneath the circuit breaker are two ammeters, one of which measures the total current received from the line, and the other the current used by the traversing motor, which is taken from the line partly and partly from the motor-generator set. Next are three switches, the left-hand one of which is connected to the main line and supplies the circuit of the elevating motor; the middle one is connected to the main line and supplies the circuit of the motor-generator set, and the other one is connected to one armature of the motor-generator set and supplies the circuit of the traversing motor. Underneath is an automatic starting rheostat with no voltage release for starting up the motor-generator set. This is so arranged that if the voltage fails from any cause the rheostat will be turned off and the motor-generator set shut down.

Two traversing controllers of type designed as P 5, to be located, one at the azimuth scale and one on the sighting platform, so that the carriage can be operated from either of these two positions. A double-throw switch connects the controller to be used and disconnects the other. These controllers consist of a cast-iron frame with a sheet-iron cover and containing a cylinder and insulated contacts so that the different combinations of circuit for the control of the traversing motor can be made. These controllers have nine speeds in either direction. They have a wheel with one notch cut in it, into which a pawl is held by means of a spring. When the controller handle is turned to the off position, the pawl falls in this notch, so that the operator can tell by the feeling that the motor is turned off. At the bottom of the controller is a coil connected in the circuit, and the controller is so arranged as to form a magnetic circuit about the fingers or contacts, so that when the current is interrupted the arc that tends to be formed is instantly broken by the magnetic field, thus greatly increasing the life of the contacts and preventing them from being burned.

A controller for elevating, depressing, and retracting, known as R–28 B, is of the same general construction and dimensions as the P 5 controller, but has a different arrangement of contacts, and has five speeds in either direction. In this case, as the armature circuit passes through the various contacts connected to the rheostat, the star wheel is provided with notches for each running position so as to insure a good contact being made at each position of the controller. This is not necessary in the case of the P 5 controller, as the different positions of the controller, except the off position, affect only the field current, which is very small. This controller is located near the elevating vernier.

Two rheostats, one to be used with P 5 controller and one to be used with R–28 B controller, each consists of a slate slab with suitable binding posts supported upon side frames carrying resistance, the material of which consists of German silver or nickeline-alloy wire pressed in cards and insulated with asbestos. These rheostats should be installed so that the resistance material will not be subjected directly to the rain.

The system of connection of the complete outfit is shown on the diagram, which shows also detail development and connections of the controllers. The two armatures of the motor-generator set are connected in series, and when the P 5 controller in the circuit is turned to the off position, the two armatures are started up as a single motor by means of the starting rheostat on the switchboard panel. The fields of the two machines of the motor-generator set are connected in series, but in the off position of the controller the generator field is nearly short-circuited. When it is desired to use the traversing motor, the motor-generator set should be started up and brought up to full speed. The generator will then produce a few volts potential at the line terminals of the controller. At this position of the controller the armature of the traversing motor is short-circuited.

By the action of the controller the rheostat, which is connected to it, is connected in multiple with one of the two fields of the motor-generator set. On the off position this is the upper portion above R–1 in the diagram. When the controller is turned to the first position this one section remains in multiple with the generator field. There is no shunt across the motor field, which will have full strength; the short-circuit connection is removed from the traversing-motor armature and its terminals are connected to the lines connecting to the generator. The armature of the traversing motor will then turn slowly. In the next position of the controller two sections of rheostat are connected in multiple with the generator field. This weakens the shunt and therefore strengthens the field and increases the voltage of the generator, and, therefore, increases the speed of the traversing motor. On the fifth position of the controller neither rheostat is connected in the circuit, and the generator and motor fields are directly in series across the main line, each one, of course, receiving half its potential. The armature of the generator is then giving potential equal to about half that of the main line, and the motor armature is receiving that potential also. The current received from the line and passing through the motor of the motor-generator set passes on to the traversing motor, and, operating as a motor to drive the generator, it also produces a current in the generator which is added to that received from the line, so that the current received by the traversing motor is equal to the sum of the currents of the motor and generator of the set. In the sixth position of the controller, through one-half the rheostat, a shunt is made around the motor field, thus weakening it and reducing its counter electromotive force. This increases the potential of the generator armature and thus increases the speed of the traversing motor. Further turning of the controller reduces the amount of resistance in shunt with the motor field, therefore increasing the current in the shunt and decreasing that in the motor field, and increases the voltage of the generator until in the last position of the controller there is only a small portion of resistance in shunt with the motor field. The motor at this point receives about the same amount of current from the line that the traversing motor receives, and the current of the generator of the set has become practically nothing as the current of the generator decreases, and that of the motor increases as the controller is turned from the off position to the full-speed position. The motor field is not absolutely short-circuited, as it is necessary to keep a little strength of field in the motor to make up for small losses of the motor and generator; that is, to overcome the friction, etc., of the motor-generator set. When the controller is turned from the full-speed position toward the off position, the conditions mentioned above are reversed, the motor field is gradually strengthened, the potential of the generator gradually reduced. This reduction of voltage retards the speed of the traversing, as the momentum of the gun carriage is likely to drive the motor as a generator if the controller is turned off very quickly, and as the voltage of the generator is reduced, the current passes from the traversing motor and through the generator armature, bringing the carriage to a very gradual and easily reduced speed until, on the off position, the armature of the traversing motor is short-circuited by the contacts of the controller acting as an electric brake and bringing the carriage to a stop; but the gradual reduction of voltage on this motor during the time of the turning off of the controller makes the stops so easy and gradual that there should be, if the rheostat is properly adjusted, no sudden strain on the machinery when the off position is reached. The field rheostat is adjusted before leaving the factory to give what is supposed to be the best arrangement of voltage for producing a gradual and easy acceleration in starting and an easy and gradual retardation in stopping, but it is possible that the rheostat will need to be readjusted in actual conditions.

A dial plate on top of the controller shows the position of the cylinder, and the second dial plate on the sighting platform has points to correspond.

The R–28 B controller used with the elevating motor is located at the elevating scale, and has a corresponding dial plate on the sighting platform as well. This has five speeds in either direction and controls the speed of the motor by inserting more or less resistance in the armature circuit, short-circuiting the armature on the off position of the controller so as to act as an electric brake and give an instantaneous stop. On account of the less inertia of this mechanism, it is not necessary to have the voltage controlled, as in the traversing mechanism. The bottom contacts of the cylinder are so arranged as to reverse the direction of the current through the armature when the cylinder is turned in the opposite direction. Development of the cylinder shows that when the cylinder is turned to the first position the current from the main line, not from the small motor-generator set, passes through the armature and the whole rheostat, thus starting the motor and giving it a slow speed. When the controller is turned to the second position one portion of the rheostat is short-circuited, thus increasing the potential on the armature and increasing its speed, and so on until on the last position the rheostat is entirely cut out of circuit. The fingers of both controllers are provided with adjusting screws, so that the amount of motion of the fingers can be adjusted. These should be adjusted so that the fingers all leave their respective contacts at practically the same instant; that is, the six fingers bearing on the four bottom rings and the two rings should all be so adjusted that these six rings will leave them at the same instant, so as to divide the arcing between all of them. They should be adjusted so that they will drop down about $\frac{1}{16}$ to $\frac{1}{32}$ inch when the contact rings leave them.

NOTE.—It is important to note that in these electrical-control systems there is no arrangement for automatically breaking the circuit and terminating the motion as the limits of traversing, elevating, and retracting are approached. Therefore, to avoid injury to the mechanism by striking the stops at high speed, it will be essential, as it has been in the hand maneuvering, but to a greater degree, to exercise care to approach the limits of motion slowly.

EXPERIMENTAL ELECTRIC EQUIPMENT (Pl. X).—Carriages 7, 10, 12, and 19 have at present the experimental equipment for retracting only.

ELECTRICAL EQUIPMENT (Pls. XI, XII, and XIII).—Carriages 9 and 17 have an equipment identical with those on 12-inch disappearing carriage, L. F., model of 1901. (For detailed description, see that pamphlet.)

ILLUMINATION.—For general illumination the carriage is provided with three 16-candlepower 110-volt lamps (with exception of carriages Nos. 6 and 7, which have 220-volt lamps) for lighting the right and left sides and gearing, controlled by one switch.

A portable 16-candlepower 110-volt lamp (carriages 6 and 7 have 220-volt lamps) with a push-botton switch in its socket may be plugged into boxes at front or rear of chassis.

The elevation disks, azimuth pointer, and throttling valve are each provided with an 8-candlepower 110-volt lamp (carriages 6 and 7 have 74-volt lamps) and the telescopic sight with two 2-candlepower 110-volt lamps, controlled by a switch on the left standard.

ELECTRICAL CONDUCTORS.—Electrical conduits for the motor, lighting, telephone and telautograph are taken through a 3-inch flexible metallic hose from the terminal box on the base ring to the conduit system on the carriage.

AMMUNITION TRUCK AND SHOT TONGS.—The ammunition is brought to the gun and the projectiles wheeled into the breech recess on ammunition trucks. Three are furnished with each carriage. The shot tray upon which the projectile rests can be raised to a suitable height and is so supported that it can be given the required angle of inclination to bring the axis of the projectile into alignment with the axis of the piece. Stops on the tray abut against the breech face and insure stability during ramming.

The frame of the truck is built up mainly of angle irons riveted. The shot tray and cartridge shelves are of steel plate formed into shape. The truck is supported by three wheels, the front pair being large and most heavily loaded, all of which are rubber tired. It is provided with a brake on the two front wheels, arranged to be operated by hand by the man at the truck handles.

Each carriage is provided with seven shot tongs for handling the projectiles. They are made of forged steel, riveted and bolted together. In order to provide tongs having the least possible height over all, they are designed to use a locking link, which must be operated to hold the arms in position on the projectiles, and with the gripping dog or eyepiece, the inner toe of which is pressed against the top of the projectile by the upward pull in the eye, thus preventing it from slipping out endwise if not properly balanced.

General Remarks.—An elevating band for the gun to be mounted, and the necessary tools and implements are furnished with each carriage. The pinch bars and retracting cranks are placed on hooks on the sides of the chassis, and implements for the gun and carriage and the tools are, excepting those too large, neatly packed in an armament chest marked with the number of the carriage, etc., to the inside of the lid of which is affixed a list of the contents.

There are plates on the carriage indicating the direction of motion of the elevating handwheels and of the traversing and retracting cranks; also instruction plates for filling, etc.

The electrical apparatus is also supplied with direction plates.

Drainage holes are drilled in all pockets, and all axles, trunnions, and sliding bearing surfaces are provided with oil holes, closed by screw plugs.

The six main axle bearings—gun trunnions, gun-lever axle, and crosshead pins—are supplied with compression grease cups.

These cups, by means of a spring-actuated cup leather plunger, automatically force the lubricant through the passages and distributing grooves under the bearing surfaces.

ASSEMBLING THE CARRIAGE.

Implements.—The assembling requires machines and implements for mechanical maneuvers usually found at forts, but, in addition to falls, blocking, jacks, sling chains, etc., shears capable of lifting 14 tons will be found necessary.

General Remarks.—The size of the carriage is such that it must be dismantled for shipment, so that when it arrives at its destination it has to be entirely assembled.

In assembling the carriage, as in all machinery, no parts should be directly struck with a steel hammer or sledge. Soft-metal drifts or copper or lead hammers should be used.

In unloading or handling the parts care should be exercised that the edges or finished surfaces do not become upset or burred. When two bearing surfaces are brought together it is especially necessary that both parts should be absolutely clean, smooth, free from burs, and well lubricated.

Those parts and surfaces inaccessible after mounting, such as the interior of the crosshead and the buffer plates, will be cleaned and painted before assembling. Such surfaces if not thus protected would rust badly and the buffer plates would soon become inelastic.

In assembling machined surfaces put on a thin coat of slushing oil; slush the threads of all screws and bolts and the under surface of all nuts. No slush will be applied to rollers and paths, as this would result in an accumulation of dirt on the surfaces.

The following description gives a statement of the order in which the parts should be put together rather than a complete enumeration of the details of the operation:

EMPLACEMENT.—The anchor bolts are set in the concrete during its construction so that they project above the surface 7.375 inches. Shallow depressions are left around these bolts in which are placed the cast-iron shoes, and on them the steel wedges and the sheet-iron covers, the bolts passing through the openings in them.

BASE RING.—Move the base ring, in sections, to its position over the pit by means of skids and rollers, placing the part marked "FRONT" to the "front" of the battery.

Carefully clean and oil the ends of the base-ring halves, and see that there are no burrs to prevent the ends being drawn tight. Clean and oil all bolts, nuts, and keys, and bolt the sections securely together.

Then caliper the outside of the pintle, and unless the ring has been strained the diameters ought not to vary from each other by more than 0.01 inch.

If the ring is found to show more than 0.01 inch ellipticity, the surfaces of the joints should be reexamined, and, if imperfect, scraped until the base ring can be sprung *round* by tightening the bolts.

Then lower the ring until it rests upon the bottom flange, with the foundation bolts as nearly central in their holes as possible. Hold the bolts in this position by means of wedges curved to fit round the bolts.

LEVELING.—Twenty-four leveling wedges, through which the foundation bolts pass, provide an easy means of leveling and give the base ring proper support on the concrete, and enable the grouting to become properly set while the rest of the carriage is being assembled.

The threads of the platform bolts and nuts should be carefully examined to see that they are not burred and are free from rust. After they are put in order, thoroughly oil the threads of both bolts and nuts. In screwing down the nuts on the platform bolts the thin nuts should be placed underneath; take up on each bolt a little at a time, so that no part of the base ring shall be strained, and finally set back the lower nut against the upper to jam. The greatest care must be exercised in using the "level" and "straightedge" that the middle of the level is equidistant from the points of contact of the straightedge with the surfaces being leveled, and that these points of contact on the straightedge are equidistant from either end.

In using the level it should always be reversed and the mean of the readings in the two positions considered the true reading. The preliminary leveling may be done from the top of the pintle inside the azimuth circle. Commence at the highest point around the ring and noting that this point is down on clean concrete, or the proper distance below the crest of the parapet, level around each way and jack up the low points.

Finally, radially inside of bolts, place the straightedge on the turned surface just inside the dust guard and follow around circumferentially each way, on this surface, leveling and tightening the foundation bolts until no low spots are found, and the nuts are screwed down. Next proceed to level the ring radially, using the "leveling gauge" furnished, on the roller path to see that it is not sprung conically.

Then again level around circumferentially on the top surface inside of the azimuth circle, and caliper the outside of the pintle once more. If the pintle shows more than 0.01-inch ellipticity the ring has been strained, and the foundation bolts must be loosened and the whole operation repeated until the ring is true and level. After the base ring is properly leveled and bolted in place pour under it a grouting of neat Portland cement.

DISTANCE RING AND TRAVERSING ROLLERS.—Clean the pintle surfaces, roller paths, rollers, roller bearings, and distance ring. See that the joints of the distance-ring sections are free from burrs and thoroughly oil the surfaces; also all bolts and nuts.

Assemble the ring one section at a time, such section being supported on the roller path by its own roller. After assembling, the roller system should be run around several times by hand, to see that it works freely and that the rollers do not bind in their bearings in the distance ring and that their flanges do not bind on the inner edge of the roller path.

RACER.—Move the racer over its position on the traversing rollers, and bolt the sections together, using the same precaution against dirt, etc., as in bolting up the base ring. Caliper the inside of the pintle surface. This, too, should be less than 0.01-inch ellipticity. Lower into position, keeping the racer as nearly level as possible to prevent the pintle surfaces from jamming. Assemble the dust guards as soon as possible after the racer is in position, to protect the rollers and roller path.

The racer should then be run around by hand several times to see that it is entirely free in action.

TRANSOMS.—Place the transoms in position on the racer, after carefully looking after all bearing surfaces and bolt holes. Screw the bolts almost home, leaving a little clearance under the heads.

Chassis.—The chassis are now placed, one at a time, on the racer and the bolts to racer and transoms screwed almost home, after which the keys and dowel pins are driven solid and all bolts sent home by successively tightening each bolt by a small amount, until all are under sufficient initial tension not to work loose.

Traversing Gearing and Clips.—As it is now needed this gearing will be assembled. The intermediate bevel gear, together with the traversing pinion-shaft bearing and bracket, may all be assembled on the pinion shaft and then placed in position on the racer and against the chassis. This can be done by moving the lower bracket against the friction ring before dropping into position. The traversing pinion is keyed and pinned on from underneath after the shaft is in position. Assemble both gears and brackets on traversing intermediate shaft before bolting to chassis.

After assembling the traversing gearing and clips traverse several times around to see that there is still no binding of rollers and that they are evenly loaded, then place the carriage successively at four points, 90 degrees apart, and at each carefully note that crosshead guides are vertical in both directions, and that chassis rails are level across and of the designated slope.

Any variations found by these tests indicate imperfect setting of the base ring, which should be carefully examined and remedied, or else imperfect work on the carriage.

Gauging Top.—The recoil-roller-path gauge should now be adjusted to fit the path on the top carriage at the middle of its length and then tried upon the paths on the top of the chassis. Should these paths be out of parallel or differ anywhere in their length from those on the top carriage the surfaces of the joints or transoms and chassis must be examined and, if not perfect, either scraped or shimmed.

Crosshead Guides.—In like manner caliper the crosshead guides and compare them with the crosshead. The crosshead guides may show a little further apart at the top than at the bottom, but it is to be expected that the weight of the remaining parts yet to be assembled will close the tops slightly. The movement of the crosshead over its guides should be free, and all binding surfaces should be worked down.

Motor and Conduit System.—The motor, its bracket and attachments, and the principal parts of the conduit system and wiring can be more conveniently assembled now than after the through shafts are in place.

Bottom-plate and Suspension Rods.—Place the counterweight bottom plate in its proper position and at about 6 inches above the under side of the base ring for the out-of-battery position of the carriage, supporting it upon firm blocking. (If more convenient to bring the gun from the front, the in-battery position may be used instead, in which case the top carriage will be assembled against the counter-recoil stops. In this case be careful not to get the counterweight more than 75 inches below the base ring.) Pass the suspension rods through their holes and make the lower connections.

A wooden templet should be used to locate the position of the suspension rods with reference to the crosshead guides so that they will line up with the holes in the crosshead.

COUNTERWEIGHT.—Lower the counterweight into position over the rods in the order in which the layers are numbered. It will be found to give less trouble if the rods are placed in position first and not after the top layer under the crosshead has been piled.

CROSSHEAD.—Lower the crosshead over the guides, being careful not to jam or mar the liners, and make the top-rod connections with the keys. The "centerpiece" of lead must be in place before crosshead keys are inserted.

The small hand weights are omitted until the gun has been allowed to run into battery.

TRIPPING GEAR.—Assemble the tripping gear complete.

If it should ever be necessary to raise or lower the counterweight when the gun is not mounted, it must be done carefully by means of jacks and blocking. The recoil cylinders can not be used as buffers to check the fall of the counterweight without the assistance of the gun as a counterbalance.

RETRACTING GEARING CLUTCH AND BRAKE.—The drum shaft is assembled first, being entered from the left through the parts and bearings. (*a*) Assemble clutch spring and seat; (*b*) insert shaft; (*c*) screw up flange bushings; (*d*) key drums, hubs flush with shoulders on shaft; (*e*) place collar behind second pinion to give 0.02-inch play; (*f*) assemble clutch shipper and brake. The crank shaft is entered from the right.

After the gun has been allowed to go in battery the first time reeve the retracting ropes through the buffer brackets, pass through the holes in drums, and, with loops over the hooks on gun levers, draw ends tight with a little more than one turn around the drums. With the clamps set moderately tight turn the gearing so as to slip both of the ropes under them, thus securing equal length and tension of ropes, and tighten clamps.

When gun is nearly retracted the first time see that the pawls click together. Should one click before the other it indicates that the rope on that side is too short.

ELEVATING GEARING.—Thoroughly clean and oil, and assemble the elevating slide with screw, springs, nut, and rope for balance weight attached in the guide way in the rear transom, and place the cover over the gearing on top of transom.

The gears and collars are assembled on the elevating shaft in order, after which assemble the elevating handwheels.

Complete the assembling of the counterbalance device.

Assemble the maneuver lever with its idler gear to the shaft of the retracting motor.

RECOIL ROLLERS—TOP CARRIAGE.—Each cage of recoil rollers should be thoroughly cleaned and oiled and tried on their paths, and run as far as possible each way to see that they work freely. After placing the rollers upon the chassis lift the top carriage and slide it into position on the rollers and against the counter-recoil stops. After running it to the rear as far as possible several times by hand, to see that the carriage itself runs freely, the piston rods and brackets at the rear ends of the chassis may be assembled. The thin nuts on the front ends of the rods should be put on first and screwed down tight, then the thick nuts screwed down upon them, after which the thin nuts should be started back against the thick ones. This applies wherever locking nuts are used on bolts. Again run the carriage to the rear several times without any packing in the stuffing boxes to see that the piston rods are concentric with the bores of the cylinders. Should there be the least binding, it should be entirely remedied before proceeding further. Then run the top carriage to the rear and place pieces of timber between the counter-recoil stops, long enough to hold the top carriage in the proper position for receiving the gun-lever axle, and making the crosshead connections with the gun levers. If the crosshead is at the proper height, the length of the piece of timber will be 66.875 inches.

(If the gun is to be mounted from the front and the counterweight has been assembled for the in-battery position, the top carriage will be against the counter-recoil stops.)

As the top carriage is generally received assembled with packing and cylinders full of oil, the above necessitates dismounting and reassembling and repacking, *for which see "Care of Carriage; General Instructions."*

GUN LEVERS.—Thoroughly clean, remove burrs from, and lubricate the gun-lever axle and axle beds on top carriage. Raise the gun levers and lower the axle into its beds on the top carriage.

The levers will then be in nearly horizontal position if mounting in the from-battery position, and nearly vertical if mounting in the in-battery position.

Lift the rear ends and move the top carriage until the crosshead pins can be inserted through the crosshead and the levers. Insert them and key them in place. Bolt the axle caps in place and assemble the brackets at the rear ends of the chassis.

GUN.—Carefully clean, remove burrs from, and lubricate the trunnions of the gun and the trunnion beds.

Mount the gun, bolt the cap squares in place, and if mounted from the rear block up under the muzzle of the gun and secure it to the front of the chassis by means of ropes.

In certain cases it may be more convenient to mount the gun from the front, bringing it over the parapet breech end first. In this case, the counterweight, gun levers, and top carriage having been assembled in the firing position, so that as the gun approaches over the top of the parapet the trunnions will be lowered slightly into their beds, the blocking under the breech will be allowed to remain until the elevating system is entirely assembled. It will be impracticable to change the height of the counterweight before the gun is mounted to balance it.

Elevating Arm and Band.—In order to properly assemble a band, holes must be drilled if they are not in the gun when received. Great care is necessary in locating these holes that the axis of the band trunnions shall be in the same plane with and parallel to that of the gun trunnions, and distant 120 inches therefrom. *This should never be done except under the supervision of the Ordnance Department.*

Distances must be measured from both trunnions, and careful inspection made by striding level or otherwise to insure parallelism. It is well to use ground emery and oil between the band and the gun to make the band grip tighter. After the band is properly placed, screw up bolts through the lugs as tight as possible, and then the set screws already set into the gun should be set up to bottom.

Assemble the lower end of the elevating arm to the elevating slide and raise the upper end to position on the band and screw in the band trunnions.

The elevating slide may be moved either way to give the proper position of the arm, or the gun may be swung on its trunnions to permit the elevating arm to receive the band trunnions.

In assembling the elevating arm it should be noted that it does not bind the band trunnion through any inaccuracy.

After the arm and band are assembled and inspected both in and out of battery to see that they do not bind, again tighten the bolts to give the band a greater initial tension than will come on it from firing.

Remaining Parts.—The working and sighting platforms, ladders, sight standard and mechanism, firing attachments, and other small parts and appendages can now be assembled, and any unfinished wiring and conduit work completed.

Controllers.—Erect the controllers for the electric-motor equipment, and assemble all electrical switches, etc., in their proper positions. In attaching the safety firing switch, take especial care that the single blades are in line with the openings between the double blades.

After Assembling.—When the carriage is completely assembled and the cylinders filled with oil, carefully inspect it to see that nothing is overlooked, after which remove all the blocking under the counterweight or gun and clean and oil all working and transversing surfaces. Place the retracting ropes over the hooks on the gun levers, trip the pawls and allow the gun to rise slowly to the firing position against the stops by unwinding the ropes slowly. *Do not attempt this with too much counterweight.* Always detach the ropes from the gun levers immediately after retracting.

If the action is satisfactory, the carriage may now be tripped and the gun allowed to run into battery several times to see that everything works properly.

The small pieces in the top layer of counterweight should be added gradually (about 500 pounds at a time) until the proper amount of counterweight necessary to raise the gun to the firing position in about seven seconds without material shock on the counter-recoil stops has been determined. Again inspect and tighten everything which may have become loosened.

Important Points.—After the carriage has been completely assembled and the gun mounted, the following points should be noted, viz:

1. Traverse the carriage each way and elevate and depress the gun to see that they work freely.

2 Examine and clean out all oil holes, noting that they have oil plugs.

3. See that there is not a hard bearing between the rimbases of the gun and gun levers.

4. See that the elevating arm and band are properly assembled, the clearances on each side being the same, and the arm not sprung or twisted.

5. See that the chassis rails and crosshead guides have not been burred.

6. See that the retraction ropes are properly adjusted, follow grooves on drum, and are not twisted.

7. See that the dust guard does not bear against the distance rings or racer.

8. Adjust the counterweight until gun rises as promptly as possible into battery without striking the stops with violence, and noting that the counter-recoil buffers act efficiently.

9. See that the piston rods are parallel to the tops of the chassis rails and also to their inside edges.

10. See that the stops to limit the motion in azimuth and depression are properly placed for the particular emplacement.

11. See that the pawls engage simultaneously on each rack of the crosshead and that the tripping and safety-tripping devices function properly.

12. Set the elevation pointer by the use of a clinometer supported by a rest in the muzzle of the gun, dowel pin it in position, and verify the graduation.

13. Orient the gun, add numbers to the degree marks on the azimuth circle, adjust azimuth pointer to indicate correct azimuth, and dowel pin it in position. Muzzle at true south is 0 degrees in azimuth, and numbers are placed around clockwise to include 359.

14. Adjust the sight standard and clamp it in the left standard so that an accurate telescope, set at "3" deflection, will sight on the same distant point covered by the bore sight.

15. Traverse the carriage to its extreme positions against the azimuth stops and then haul the gun down to see that nothing will interfere with its recoil in these positions. When in these positions note that the counterweight if tripped would not fall in the bight of the electric-conduit cable.

16. See that electrical connections have been properly made by trying the motor and the lights.

Care of Carriage; General Instructions.—Carriages should be traversed from time to time throughout their entire allowed movement. They should not be allowed to stand for long periods set at a particular azimuth, as this might cause uneven settling of the platform.

The habitual position of guns on disappearing carriages is "from battery," but at intervals the gun should be allowed to rise to the firing position and be elevated and depressed within the limits of the stops.

It is especially required that all parts of carriages be kept free from rust *at all times*. If this be allowed to accumulate, its removal from all bearing parts, and especially piston rods, requires particular attention in order that clearances shall not be unduly increased. The use of sandpaper for this purpose is forbidden, and emery cloth No. 1, being coarse enough for any ordinary rusting, should be used, the rust being softened, if necessary, by kerosene.

The retracting wire ropes should at all times be kept well oiled with raw linseed oil.

If any leakage occurs from the hydraulic-recoil system, it should be immediately remedied, calling, if necessary, upon the district armament officer for the services of skilled labor.

The repacking of stuffing boxes may be done, when necessary, by trained enlisted men, under the supervision of an officer, but will preferably be done by skilled labor.

Before removing a cylinder head containing a stuffing box or drawing a piston rod through a stuffing box, the pressure of the packing on the rod should be released by unscrewing the follower several turns.

The vulcanized fiber or copper gaskets between cylinders and their heads should be in good condition, and consequently should be replaced whenever necessary in order to prevent leakage.

Recoil cylinders should be emptied at least every three months and thoroughly cleaned every six months.

Instructions for Cleaning Recoil Cylinders.—For this cleaning a plumber's hand force pump will be supplied to each coast-artillery post, with about 10 feet of suction hose and 15 feet of discharge tube.

It will be noted that in no case will it be necessary to remove the packing from a stuffing box to clean the cylinders.

In cleaning the following order of operations may be followed:

(*a*) Run gun into battery and remove oil from hydraulic-recoil system.

(*b*) Retract gun until pistons are in the middle of the cylinders; then slack away until the pawls engage in the ratchet teeth on the crosshead; observe that the pawls are properly engaged in the ratchet teeth and that the pistons are not under the filling holes.

(*c*) Remove the piston-rod brackets from the rear ends of the chassis rails. Take off the two nuts on the front end of each piston rod, remove the rear cylinder head from each cylinder, and carefully remove the rods rearward out of the cylinders. Before removing any part, it should be marked so as to insure its being assembled in its correct position.

(*d*) Thoroughly clean each cylinder from both ends with kerosene oil forced in with a hand pump; then wipe dry with clean cotton waste. Clean the piston rods and stuffing boxes. The equalizing and connecting pipes should be dismounted and thoroughly cleaned by forcing kerosene oil into them with the pump.

(*e*) Assemble the equalizing and connecting pipes, leaving the throttling valve wide open. Insert each piston rod in its cylinder, exercising great care that it be neither bent nor damaged in any way and that the piston does not bind in or burr the walls of the cylinder. Assemble the two nuts on the front end of each rod. Place each rear cylinder head on its rod and move it forward into its seat in the cylinder. Assemble the piston-rod brackets to the chassis and then firmly secure the rear cylinder heads to the cylinders. Properly tighten the four followers of the stuffing boxes and fill the recoil cylinders with hydroline oil. This will require some time, as the oil can enter the parts of the cylinders in rear of the pistons only through the equalizing pipes and the throttling-bar orifices. When apparently filled, insert the filling plugs, close the throttling valve, and retract the gun to the loading position. Complete the filling of the cylinders and close the throttling valve to its proper setting.

Carefully inspect all parts dismounted and note that they have been properly assembled. Then trip the pawls and let the gun rise into battery.

The piston-rod nuts should then be loosened to insure the rod being centrally located in the cylinder and the nuts finally tightened.

The gun should be retracted and tripped several times to insure that all parts are in proper working order.

REMOVING PACKING FROM STUFFING BOXES (using new extractor, to be furnished by the Ordnance Department).—Close the extractor around the piston rod and insert the locking pin. Turn the extractor to the left, with pressure on the packing, until the needles are firmly engaged in the packing. Draw the packing out, turning slowly to the left. In the case of a box with interior thread, and if the ring is tight, it should be unscrewed and not stripped out by the thread, because unless unscrewed it would catch upon and be injured by the thread.

Extractor bars are provided to be used for starting the packing from its seat and by inserting the toes of the bars in the rack teeth and prying over the edge of the box, being careful not to injure the thread.

TO PACK OR REPACK A STUFFING BOX.—Examine the old packing and discard all unfit for use. If any of the old packing is used, it should be put in after the new.

To repack, put on the piston rod one ring of 0.75-inch Garlock's "waterproof hydraulic" packing and force it well to the bottom of the stuffing box by a wooden stick and mallet. Treat each layer of packing in a similar manner, being careful to break joints, until six rings of new packing have been inserted, or an equal amount of new and old when any of the latter is used. Place the halves of the gland on the follower, enter them together in the box, and screw up the follower, being careful to note that the halves of the gland do not bind on the screw threads.

No more force should be used on the spanner wrench than that of two men, and generally that of one man is sufficient. The addition of a pipe to the end of the spanner wrench should not be permitted.

When the box is properly filled and the follower tightened, there should not be more than 1 inch of space between the flange of the follower and the piece into which the follower is screwed. The follower should be tightened from time to time. If the follower is screwed into the stuffing box too tightly, an unnecessary amount of friction will be produced on the piston rod. When the follower is screwed in until the flange strikes the box, another ring of packing should be inserted.

It is to be expected that a slight amount of oil will soak through and drip from boxes of carriages when not in use. Also when tightening the followers a slight amount of oil will squeeze out of the saturated packing. This oil should be caught and not allowed to render the carriage unsightly.

FILLING RECOIL CYLINDERS.—Fill the cylinders with oil, removing for this purpose the two plugs, one in each cylinder. Pour clean neutral oil of specific gravity about 0.85 (such as the "hydroline" now issued to the service) into the hole in one cylinder until it flows out of the hole in the other. Allow any air that may be present to escape, then pour in more oil, until the system is filled to the level of the filling holes. About 64 gallons are required.

The cylinders will then be not full, but as nearly full as they are intended to be. The filling holes are intentionally placed below the highest point of the cylinders in order to leave above their level a void (or air space) equal to the volume of the counter-recoil buffer plus a few cubic inches to allow for expansion of the oil when heated by the weather or otherwise.

SERVICE CONDITION (LUBRICATION, ETC.).—When the carriage is to be kept in readiness for service, and is in daily or frequent use, all bearing parts must be kept thoroughly cleaned and lubricated. Especial attention should be given to the lubricating of trunnion beds, rollers, pintle surfaces, shaft bearings, and sliding surfaces, gun-lever axle beds, crosshead pins, elevating rack, elevating-band trunnions, crosshead guides, and the elevating, traversing, tripping, and retracting mechanisms, including the teeth of all gears.

The above parts should be lubricated at frequent intervals, whether the carriage is maneuvered or not. When carriages are in use for daily drills, a thorough lubrication twice each week should be sufficient for all but the most severely used parts.

Proper lubricating and cleaning of the traversing rollers and their paths are essential to free working of the carriage. The base ring has inner and outer vertical flanges, forming with the lower roller path a trough, which may be filled with oil if desired, for the rollers to work in. Drainpipes leading to the interior of the base ring and closed by screw plugs permit of draining this trough. This construction also permits of flushing out the trough and the roller and paths with oil. The dust guards may be removed to oil the traversing rollers, or to clean them, or the paths, or for other purposes. By removing the cover plates on the racer, which close the openings near the racer joints, the rollers may be examined or oiled.

It will occasionally be necessary to examine all ball and roller bearings to see that the dust guards are in proper place and that the rollers themselves are clean. If they be found dirty, they may be flushed with kerosene oil; but care must be taken to fill the bearings with synovial oil after the kerosene has drained away. If the rollers have rusted, the bearing must be taken out, the rollers cleaned, and the bearings reinserted.

INSTRUCTIONS FOR LUBRICATING RETRACTING MOTORS.

These motors are provided with two pockets in the frame for lubricating grease. Each pocket is immediately over the armature shaft bearing and the slot in the bottom thereof allows the grease to have access to the bearing. The pockets should be filled with Albany grease No. 3, or one of similar qualities and consistency. After filling the pockets the covers thereof should be closed.

If the temperature is below 60° F., the grease should be removed from the pockets before the motors are operated, to enable a small quantity of lubricating oil to be placed on the shaft through the pockets. The grease should then be replaced and pressed downward on the shaft by means of a piece of wood.

CONDITION "IN ORDINARY" (not ready for immediate service).—If the carriage is to remain unused for a time, all unpainted surfaces should be covered with a *thin* coat of light slushing oil. It can be applied as in painting, using sash tools No. 6, except in cold weather it should be applied by stippling, i. e., light tapping, with the brush held perpendicular to the surface to be covered.

Should it rain within thirty hours after its application, all surfaces should be carefully examined, and recoated if necessary. *In all cases it should be applied in a thin coat, as this is all that is needed to give good protection.*

This oil is easily removed by the use of burlap or waste dipped in kerosene oil. In order to save oil a thick coating of slushing oil should be well removed by a scraper before applying the kerosene.

Before applying the slushing oil the surfaces should be thoroughly cleaned so as to be entirely free of rust, water, kerosene, lubricating oil, etc., as the first three would cause rusting underneath, and in the latter case it will run off when heated.

Rollers and roller paths should be cleaned and slushed, the space between dust guards and base rings, if not felted tight, should be corked with oakum or waste to keep out the dust, and any wrench holes inside the base ring should be plugged and corked.

Experience has shown that recoil cylinders should not be emptied, as in that case the interior walls soon become dry and rusty.

OIL HOLES.—Oil holes, where provided, must be cleaned out frequently to keep them free from sand and grit, and will habitually be kept closed by the screw plugs provided, except when in the act of oiling.

Before oiling at any oil hole, wipe off carefully any dirt or grit near the opening that might be carried down into the bearing by the oil.

COMPRESSION GREASE CUPS.—Where compression grease cups are provided, similar precautions against dirt or grit must be observed. In filling these cups, do not fill the cup completely, but fill only to the bottom of the bevel at the top of the cup; if too full, the leather packing will become inverted and will not act as effectively. In putting on the cap, see that the leather-packed follower enters the cup without being caught, cut, or bent by the edge of the cup or otherwise.

Screw the cap down on the cup, using a wrench, if necessary to secure sufficient power, until the spring rod projects about 0.25 inch above the top of the cap. Later, when the spring has recovered and has moved the follower forward, forcing the grease through the tube into the bearings, which will be indicated by the spring rod being pulled into the cap until its nut touches or nearly touches the cap, it will again be necessary to screw up the cap on the cup until the spring is again compressed. When the cap is screwed nearly home and the spring rod does not project, it is an indication that the cup should be refilled.

OILS, GREASE, ETC.—The Vacuum Oil Company's No. 4½ lubricant is issued for use in the compression grease cups; it will not be used for lubricating any other parts, nor will any other oil be used in its place.

Synovial oil should be used to lubricate all bearings where oil holes and oil plugs are provided. This includes those equipped with compression grease cups.

Kerosene oil is used by the Ordnance Department for cleaning purposes only.

A special grade of neutral oil called "hydroline," having a specific gravity of about 0.85, is furnished for filling the recoil cylinders, and a barrel of this oil should be kept on hand to replace leakage.

The different kinds of oil, etc., will be kept in receptacles plainly marked with their contents, and the soldiers should be carefully instructed in the use of the several kinds of oil, grease, etc., and should be taught to distinguish one from another.

Oils must always be kept in closed receptacles to prevent contamination by water, dirt, etc.

Oils which have been used for any purpose must never be used again without being filtered or carefully strained. They should never be returned to receptacles containing new oils.

A suitable receptacle should be kept by each battery in which oil from cylinders can be placed and allowed to stand undisturbed until all sediment in it has settled. In removing the oil great care should be taken that no sediment is included.

Mere discoloration does not affect the serviceability of the oil.

For further information regarding paints, oils, cleaning materials, and methods of using same, see Ordnance Department pamphlet, Form No. 1869. Annual allowances will also be found in this pamphlet.

List of articles packed in the armament chest for 12-inch gun, model of 1895.

[NOTE.—All articles marked * are carried loose in the chest.]

1 commercial screw driver for spindle ball-bearing screws. U45AN.
1 obturator-nut wrench. U44L.
1 obturator-nut clamp-screw wrench. U44Q.
*1 firing mechanism box.
1 tit wrench for obturator. U44Y.
1 pressure-plug wrench. U44M.
1 pin punch. U47AF.
2 bronze drifts. U47AB and U47AC.
1 gunner's punch. U47U.
1 gunner's drill. U47X.
*1 gunner's pouch.
*1 pair gunner's sleeves.
*1 gunner's lanyard. U47AJ.
1 cleaning reamer, for primer seat. U47AA.
3 cleaning brushes, for primer seat. U47Z.
1 metal scraper (for removing paint, etc.). U47AE.
1 quire emery cloth, No. 00. U47BC.
*3 wagon sponges. U47AX.
*2 pounds copper wire, No. 12. U47BA.
*2 pounds copper wire, No. 16. U47BB.
*12 silk wipers (or cotton waste, 10 pounds). U47AZ.
*4 balls twine, assorted. U47AY.
1 file, flat, dead-smooth, 8 inches. U47AR.
1 file, round, second-cut, 8 inches. U47AS.
1 file, half-round, smooth, 8 inches. U47AU.
1 file, three-cornered, 8 inches. U47BH.
1 copper hammer. U47AG.
1 boiler-maker's hammer. U47AM.
1 hand mallet. U47AN.
1 long-handled mallet. U47AP.

1 monkey (screw) wrench, 21-inch. U45L.
3 files, pillar, No. 6, 6-inch. U47AW.
3 files, three-cornered, No. 4, 6-inch. U47AV.
3 files, half-round, smooth, 8-inch. U47AU.
3 files, round, smooth, 8-inch. U47AT.
1 monkey (screw) wrench, 12-inch. U45G.
1 pair cutting pliers, 7-inch. U47AQ.

List of articles packed in armament chest for 12-inch disappearing carriage, L. F., model of 1897.

1 oiler, 1 quart, locomotive (carried loose in chest).
2 oil cans, half-pint.
1 double wrench for 0.5 and 0.625 inch nuts.
1 double wrench for 1 and 1.25 inch nuts.
1 double wrench for 1.5 and 1.75 inch nuts.
1 double wrench for 2 and 2.5 inch nuts.
2 spanner wrenches for stuffing boxes.
1 box wrench for buffers and cylinder heads.[a]
1 box wrench for filling, vent, and drain plugs.[a]
2 cross-handled screw-drivers, with 12 blades (for platform screws).
3 hooks for lifting counterweights.
1 bar screw-driver for traversing rack bolts.
2 cylinder-head extractors.
2 roller axle extractors.
2 commercial screw-drivers.

The following articles, being too large, are not to be kept in the chest:

2 pinch bars (top carriage "in battery").
1 fork wrench for piston-rod nuts.
1 double wrench for piston-rod nuts and elevating band trunnion.
1 double wrench for 3 and 3.5 inch nuts.
2 water buckets, indurated fiber.
1 mallet, long-handled.

List of implements furnished for 12-inch gun, model of 1895.

1 rammer and staff.
1 sponge and staff, bore.
1 sponge and staff, chamber.
1 sponge and rammer prop.
1 breech cover.

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[a] Carriages after No. 22 have fork wrench only.

1 muzzle cover.
1 sponge cover, bore.
1 sponge cover, chamber.
1 slush brush with handle to connect with sponge staff.
1 steel scraper and socket to fit sponge staff.

List of equipment supplied for 12-inch gun, model of 1895, and disappearing carriages, L. F., model of 1897.

2 paint pots, 1 gallon.
1 sieve, for paints and oils.
2 paint brushes, wall, 4-inch.[a]
3 paint brushes, paint, 6/0.[a]
2 dusters, painter's, No. 2.[a]
3 slushing brushes, scale tool, No. 6.

Material for cleaning and preservation of 12-inch gun, model of 1895, and disappearing carriages, L. F., model of 1897.

(All expendable.)

4 gallons superior graphite paint, drab, No. 57, for guns only.

12 gallons superior graphite paint, olive green, No. 38, for carriages only.

85 pounds light slushing oil, for bore of guns, etc.

13 gallons synovial oil and 12 pounds grease-forcer lubricant, No. 4½, for lubricating carriages.

77 gallons hydroline, for filling cylinders.

25 gallons kerosene oil.

50 pounds cotton waste.

65 yards burlap.

1 packing needle.

2 pounds flax twine.

24 rings Garlock's waterproof hydraulic packing, 0.875 square and 4.75 inches inside diameter, for piston rods.

3 rings Garlock's waterproof hydraulic packing, 0.25 square and 1 inch inside diameter, for throttling valve.

1 set gaskets for carriages.

1¼ quires emery cloth, No. 1.

1¼ quires emery cloth, No. 00.

1 pound quick-drying stencil paint, black.

1 pound quick-drying stencil paint, white.

2 gallons varnish.

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[a] Expendable.

2 pounds putty.
1 gallon turpentine or dryanthin.
½ gallon dryer, succatine or equal.
8 ounces flake graphite.
50 ounces labaline.
2 pounds putz pomade.
20 pounds sal soda.
1 barrel lime for each two.
15 pounds lye.
6 corn brooms.

APPROXIMATE WEIGHTS OF PARTS OF 12-INCH DISAPPEARING CARRIAGE, L. F., MODEL OF 1897.

Name of parts.	Number of pieces.	Weights.
		Pounds.
Leveling wedges complete	24 sets.	2,825
Base ring complete, except rack	In halves.	34,290
Traversing rollers and axles	24 sets.	7,348
Distance rings complete	In halves.	2,994
Racer complete	In halves.	30,505
Dust guard complete	4 sections.	668
Chassis	2	33,221
Front transom and clip	1	4,452
Rear transom and clip		8,068
Recoil rollers and cages	2 sets.	3,480
Top carriage assembled complete, but without oil (oil, 499 pounds)	1	23,000
Piston rods	2	2,400
Piston rod brackets	2	1,129
Gun levers complete	2	24,985
Elevating arm and pin	1	2,380
Elevating band complete	1	1,490
Buffer brackets, with caps and fillers	2	2,553
Outside and inside platforms, plates and angles		4,300
Brackets and brace for outside platform	18	1,475
Elevating counterbalance		2,847
Elevating gear		2,404
Motor gear		670
Retracting gear and clutch		3,853
Traversing gear including rack (rack 1280)		2,546
Tripping gear		1,043
Sighting platforms, ladders, and rails		2,545
Right and left platform standard and brackets		3,275
Azimuth and elevation scales, pointers, and covers		505
Bolts, approximately		2,150
Motor and retracting controller		950
Sighting standard		245
Conduits, fittings and bolts, approximately		1,000
Wiring and flexible tubing, approximately		250
Firing equipment, electric and lanyard		200
Total		216,046

For gun, model of 1895, and with lead counterweight.

		Pounds.
Total weight of carriage (as above)		216,046
{Counterweight (lead)	138,635	
{Crosshead, bottom rods, etc	16,186	
Total weight of counterweight		154,821
Total weight of carriage		370,867
Gun loaded		116,240
Total weight of carriage and gun		487,107
Deduct for base ring, etc		45,350
Total rotating weight		441,757
Total weight of carriage		370,867
3 ammunition trucks		1,845
7 shot tongs		301
Implements, etc., approximately		700
Total weight of carriage		373,713

NAMES OF THE PARTS, WITH THEIR LOCATION, AND THE MATERIAL OF WHICH THEY ARE MADE.

Name of part.	Location.	Material.	No.	Diameter or width.	Length.	Nuts.	Remarks.
Arrows	Pawl levers	Brass	2				
Axle caps	Gun lever axle top carriage	Cast steel, No. 2	2				
Axles	Recoil roller	Forged steel, No. 3	26				2 large, 24 small, 26 nuts.
Azimuth circle	On base ring	Brass	1				In pieces, as convenient.
Azimuth pointer screw	Through body and slide	Bronze	1				
Azimuth pointer index	On azimuth pointer slide	do	1				1 screw.
Azimuth pointer body	On racer	do	1				2 screws and 2 dowels.
Azimuth pointer slide	On azimuth pointer body	do	1				
Azimuth pointer lid and hinge	On racer	do	1				
Azimuth pointer nut	On azimuth pointer screw	do	1				
Azimuth pointer	Bolted to racer	do	1				
Azimuth pointer collar	Azimuth pointer screw	do	1				1 ⅛-inch pin.
Azimuth pointer index plate	Bolted to racer	do	1				2 dowels.
Ball thrust bearing	Traversing handwheel shaft gear	Steel	1				Traversing slow motion.
Battery box bracket	On outside platform	Sheet metal	1				
Base ring	On platform	Cast iron, No. 2	1				In 2 parts, front and rear.
Ball-bearing balls	Between washers	Steel hardened	50	0.5			
Base ring slide	Base ring	Cast iron, No. 2	1				On some carriages.
Base ring slide screw	Base ring slide	Bronze, No. 3	1				
Brackets, front	Sighting platform	Cast steel, No. 1	2				
Buffer liner	Rear cylinder head	Bronze, No. 4	2				
Ball thrust bearing	Traversing handwheel shaft gear	Steel	1				
Buffer filler	Between buffer plates	Balata	20				
Buffer plates	Between buffer filler	Wrought iron	18				
Buffer brackets	Bolted to chassis	Cast steel, No. 1	2				
Buffer cap	Bolted to buffer bracket	do	2				
Bushing	Left standard	Bronze, No. 3	1				
Do	Recoil rollers	Bronze	52				
Do	Elevating arm	do	2				
Do	Gun lever axle bed, top carriage	do	2				
Do	Gear wheel on third pinion (retracting)	Forged steel	1				
Do	Lower end of gun levers	Bronze	2				
Do	Second pinion (retracting)	Forged steel	1				
Do	Third pinion (retracting)	do	1				
Do	Trunnion bed	Bronze, No. 4	4				
Do	Rear cylinder head	do	2				
Do	Recoil rollers	Bronze	52				4 large, 48 small.
Do	Tripping lever shaft	do	2				
Do	Chassis	Forged steel	2				
Do	Elevating slide	Bronze	2				
Buffer spring	Elevation slide	Steel	2				
Braces	Outside platform	Wrought iron	1				
Bolts, countersunk	Platform to brackets and standard	Steel	16	.75	3	16	
Do	Liners to base ring slide	Brass	10	.375	.75		

NAMES OF THE PARTS, WITH THEIR LOCATION, AND THE MATERIAL OF WHICH THEY ARE MADE—Continued.

Name of part.	Location.	Material.	No.	Diameter or width.	Length.	Nuts.	Remarks.
Bolts, countersunk	Platform to sight standard	Steel	1	.75	5.625	1	
Do	do	do	1	.75	4.125	1	
Do	Shipper fork	do	1	.75	1.875	1	Traversing slow motion.
Do	Azimuth index to slide	Bronze	1	.25	.7		
Do	Railings to platforms	Steel	16	.75	2.125	16	
Do	Angles to end of brackets	do	18	1	3	18	
Do	Fish plates to distance rings	do	24	1	4	24	
Do	Distance ring joints (fish plates)	do	24	1	4.25	24	With Verona washers.
Do	Azimuth pointer cover	Bronze	5	.5	1.125		
Do	Distance ring separators	Steel	66	1	5.25	66	Do.
Do	Angle joint outside platform	do	24	.75	1.875	24	
Do	Rope trough to support	do	14	.625	1.5	14	
Do	Azimuth circle	Bronze	60	.5	1.125		
Do	Observation cover	do	32	.75	1		
Do	Graduation strips	do	14	.1875	.5		
Do	Arrows to pawl levers	Brass	6	.1875			
Bolts, set screw	Traversing pinion shaft friction nut	Steel	1	.625	1.5		
Do	Collars on drum and retracting shafts	do	2	.875	2		
Do	Adjusting sight standard	do	2	.875	2		Round front.
Do	Elevating pin	do	1	2	4		
Do	Elevating band	do	2	2.5	12		
Do	Elevating band trunnion	do	2	1.125	5.5		
Bolts, key	Base ring joints	do	2	2.5	1.75		
Bolts, key in head	Racer joints	do	2	2.5	17.5		Tap.
Bolts, stud	Cap to rear transom	do	2	1.75	10.125	4	
Do	Cylinder heads	do	32	1.25	5.5	32	
Do	Gun lever axle caps	do	4	3	14.25	8	
Do	Traversing handwheel shaft bracket to sight standard	do	1	1	3	1	Traversing slow motion.
Do	Gun lever cap squares	do	4	2.5	14.5	4	
Do	Yoke to gun levers	do	8	2.5	10.25	8	
Bolts, headless	Racer joints	do	2	2.5	11.5	4	
Bolts, tap	Tool hooks	do	8	.875			
Do	Dust guard to base ring	do	64	.625	1		
Do	Chassis to racer	do	26	2	5		
Do	Transoms and clips to racer and chassis	do	28	2	5		
Do	Rear transom to chassis	do	4	2	10.5		
Do	Clutch and spring seat	do	2	.75	6.25		
Do	Brackets to chassis	do	18	1.25	2.375		
Do	Rear ladders to chassis	do	2	1	2		
Do	do	do	2	1	1.5		
Do	Shipper fork bracket to chassis	do	2	1	3.75		
Do	Firing pistol bracket	do	2	.625	1.25		
Do	Rope clamp and elevating slide nut	do	2	.75	1.125		
Do	Elevating connecting shaft gear cover	do		.625	1.75		

Do	Shoulder rest to sight standard	do		.75	1.75		
Do	Nut strip to shoulder rest	do		.5	1.375		
Do	Bracket to transom	do	4	1.25	4.5		
Do	Clip and racer	do	4	2	5		
Do	Battery box bracket to platform	do	4	.5	1		
Do	Bracket to chassis	do	3	.75	2.875		
Do	Pointer to bracket	do	2	.75	2		
Do	Starting rheostat bracket to chassis	do	2	1	1.5		
Do	Telephone to telephone bracket	do	4	.75	2.25		
Do	Circuit breaker box to chassis	do	4	.625	1.25		
Do	Telautograph bracket (upper)	do	3	.75	3.5		
Do	Telautograph bracket (lower)	do	2	.75	2		
Do	Safety firing switch lever base	do	3	.75	2		
Do	Safety firing switch clip base	do	1	.75	2.5		
Do	do	do	1	.75	3.25		
Do	Standards to racer	do	8	1.5	3		
Do	do	do	4	1.5	4.5		
Do	Parallel arm bracket to standard	do	6	1	2.75		
Do	Brackets to racer	do	55	1.25	2.75		
Do	Platform plate to chassis	do	16	.75	1.25		
Do	Pit ladder	do	4	1	1.75		
Do	Elevating gear cover	do	6	1	2		
Do	Elevating gibs to rear transom	do	24	1.75	5		
Do	Buffer brackets to chassis	do	8	1.75	3.75		
Do	do	do	4	2	15.5		
Do	Buffer brackets to piston rod brackets	do	4	2	14.5		
Do	Rope sheave pins	do	2	.75	1.5		
Do	Piston rod brackets to chassis	do	4	1.75	3.75		
Do	do	do	4	1.75	5.25		
Do	Lanyard filling piece	do	2	.5	1.25		
Do	Lanyard cam	do	2	.5	.75		
Do	Emptying coupling to top carriage	do	2	1	1.875		
Do	Yoke to gun levers	do	2	3	6		
Do	Crosshead gibs	do	8	.75	1.75		
Do	Key in crosshead pins	do	4	1.5	2.5		
Do	Safety latch fulcrum	do	2	1.5	7.5		
Do	Elevating shaft bushings	do	6	1	1.75		
Do	Elevation scale to elevating slide	do	4	1	3		
Do	Gear bracket to rear transom	do	2	1.5	4.25		
Do	Traversing pinion bearings	do	3	1.5	3.5		
Do	Retracting and drum shaft bushings	do	8	1	1.75		
Do	Rope troughs to carriage	do	10	.75	1.5		
Do	Rope clamps to drums	do	8	1	3.25		
Do	Platform bracket to standard	do	4	1.25	2.25		
Do	do	do	1	1.25	3.5		
Do	Break shaft bracket	do	4	.5	1.15	4	
Do	Dust guard joints	do	24	.625	.75		
Do	Elevating bands	do	2	3.5	28	2	
Do	Straps to top carriage	do	8	.5	1		
Do	Tap plugs to filling and vent tubes	Bronze	4	1	1.25		
Do	Throttling valve to top carriage	Steel	2	1	1.875		
Do	Elevating connecting shaft gear cover to sight standard	do	2	.625	1.75		Slow motion gear.

NAMES OF THE PARTS, WITH THEIR LOCATION, AND THE MATERIAL OF WHICH THEY ARE MADE—Continued.

Name of part.	Location.	Material.	No.	Diameter or width.	Length.	Nuts.	Remarks.
Bolts, tap	Shoulder rest to sight standard	Steel	4	0.75	1.75		Slow motion gear.
Do	Nut strip to shoulder rest	do	3	.5	1.375		Do.
Do	Traversing rack	do	39	.875	2		
Do	Traversing handwheel shaft bracket to sight standard	do	1	1	2.25		Do.
Do	Band trunnion set screws	do	2	1.125	5.5		
Do	Rope trough carriage	do	10	.75	1.5		
Do	Tap plugs to replace pipe connections	do	6	1.625	1.375		
Do	Traversing stops to base ring	do	8	1.25	3.25		
Bolts, through	Pawl fulcrum	Forged steel, No. 3	2	2.25	22.125	2	
Do	Traversing brackets	Steel	3	1.5	7.25	3	
Do	Traversing intermediate brackets	do	3	1.25	7	3	
Do	Retracting motor brackets to chassis	do	2	1	7.625	2	
Do	do	do	2	1	5.25	2	
Do	Recoil cuffer bracket caps	do	4	2	14.5	4	
Do	Retracting motor to bracket	do	4	.625	3.5	4	
Do	Brackets to standards	do	8	1.5	4.25	8	
Do	Brackets to chassis	do	2	2	16.5	2	
Do	do	do	2	2	8	2	
Do	Shippers	do	2	.75	3.125	2	
Do	Starting rheostat to bracket	do	4	.625	2.25	4	
Do	Traversing clutch lever	do	2	.5	1.375	2	Do.
Do	Telephone to telephone bracket	do	4	.5	2.25	4	
Do	Elevating connecting shaft gear cover	do		.5	1.625	1	Do.
Do	do	do		.5	4.625	1	Do.
Do	do	do		.5	6.875	1	Do.
Do	Elevating handwheel shaft gear cover	do		.5	1.625	1	Do.
Do	do	do		.5	3.125	1	Do.
Do	do	do		.5	4.625	1	Do.
Do	Guide to elevating connecting shaft bracket (front)	do		.75	2.125	2	Do.
Do	Traversing connecting shaft bracket to left chassis	do		.1	4.5	3	Do.
Do	Traversing handwheel shaft bracket to sight standard	do		1.5	9	2	Do.
Do	Traversing connecting shaft gear cover	do		.5	1.625	1	Do.
Do	do	do		.5	3.625	1	Do.
Do	do	do		.5	9.625	1	Do.
Do	Traversing handwheel shaft gear cover	do		.5	1.625	1	Do.
Do	do	do		.5	3.125	1	Do.
Do	Rear ladders to angles	do	4	1	2.125	4	
Do	Base-ring joints	do	6	2.5	10	6	
Do	do	do	6	2	9.5	6	
Do	Racer joints	do	4	2.5	9	4	
Do	Front transom to chassis	do	2	2.5	20	2	
Do	do	do	12	2"	13.5	12	
Do	Rear transom to chassis	do	10	2	13	8	

Do	do	do	2	2	7.25	2	
Do	Front ladder to chassis	do	2	1	3.75	2	
Do	do	do	2	1	4.25	2	
Do	Front ladders to brackets	do	4	1	2.375	4	
Do	Elevating band	do	2	3.5	28	2	
Do	Pinion shaft locking collar	do	1	.625	3.875	1	
Do	Sight standard	do	2	2	8.625	2	
Do	Ammunition truck-step bracket to frame	do	4	.625	2	4	
Do	Brake shaft bracket	do	4	.5	1.125	4	
Do	Binding sight-standard socket	do	2	1.5	7.75	2	
Bolts, washer head	Elevating-slide buffer bolts	do	2	2	17.875		
Do	Throttling bars	do	28	1.125	4		
Do	do	do	16	1.125	4.25		
Bolts, special	Tripping gear	do	2	1.5	7.5		
Corner post connection	Sighting platform	do	1				
Cap squares	Gun lever	Cast steel, No. 2	2				
Chassis	Bolted to racer	Cast iron, No. 2	2				
Clip, front	do	Cast steel, No. 1	2				
Collar	On elevating shaft	Bronze	5	4.45			With felt washers and taper pins.
Do	Retracting crank shaft	Steel	1				
Do	Retracting drum shaft	Bronze	2				Do.
Do	do	Steel	1				With set screw.
Do	Suspension rod	Forged steel, No. 3	4				In halves.
Do	Traversing shaft	Bronze	3				With felt washers and taper pins.
Do	Traversing intermediate shaft	do	2				Do.
Do	Traversing pinion shaft	do	2				Do.
Cages	Recoil rollers	Cast steel, No. 2	4				
Cover	On piston-rod bracket (right)	Steel	1				
Do	On piston-rod bracket (left)	do	1				
Counterbalance bracket	Bolted to rear transom	Cast steel	2				
Counterbalance bracket shaft	Counterbalance bracket	Steel	2				
Counterbalance bracket shaft bushing.	do	Bronze	2				
Counterbalance sheaves	On shafts and pins	Cast iron, No. 2	4				
Counterbalance equalizing bar.	On suspension rod	Forged steel	1				
Counterbalance weight	Hanging in pit	Cast iron	1				
Counterbalance suspension rod and nut.	In weight	Steel	1				
Counterbalance rope	Over sheaves	Cast steel	1				
Counterbalance guide bracket and clip.	Bolted to racer	do	1				
Counterweight, first layer	Suspended from crosshead	Lead	9				In 9 pieces.
Counterweight, second to eighth, inclusive.	do	do	14				2 pieces in each layer.
Counterweight, ninth layer	do	do	3				In 3 pieces.
Counterweight, tenth layer	do	do	72				
Counterweight, bottom plate.	do	Cast steel, No. 1	1				
Crosshead	Crosshead guides	do	1				

NAMES OF THE PARTS, WITH THEIR LOCATION, AND THE MATERIAL OF WHICH THEY ARE MADE—Continued.

Name of part.	Location.	Material.	No.	Diameter or width.	Length.	Nuts.	Remarks.
Crosshead liners	Riveted to crosshead	Tobin bronze	6				2 wide and 4 narrow, 48 brass rivets.
Crosshead gibs	Bolted to crosshead	do	4				8 tapped bolts, 32 brass rivets.
Crosshead pins	Secure gun lever to crosshead	Forged steel, No. 2	2				2 keys and 4 tapped bolts.
Cylinder head, rear	Top carriage	Cast steel, No. 2	2				
Collar	Counterweight	Forged steel, No. 3	4				Cut in halves.
Corner braces	Sighting platform	Steel plate	3				
Direction plates	On chassis (elevate and depress)	Bronze	2				8 brass screws.
Do	On chassis (retracting)	do	2				4 brass screws.
Do	On chassis (traversing)	do	2				8 brass screws.
Distance rings	Traversing rollers	Wrought iron	2				One of each in halves.
Dowell pins	Through chassis	Forged steel	4				2 in each chassis.
Dust guard	Bolted to base ring	Wrought iron	1				In 4 pieces.
Distance ring (inner)	Traversing roller	do	1				
Distance ring (outer)	do	do	1				
Depressing direction plates		Bronze	4				
Elevating retaining washer	Elevating gear	do	1				
Elevating arm	Connects gun with elevating apparatus	Cast steel, No. 1	1				Set screw.
Elevating band	On gun	do	1				
Elevating band trunnion	On elevating band	Forged steel	2				2 set screws.
Elevating band bolts and nuts	Through lug on elevating band	Wrought iron	2	3.5	28	2	
Elevating bevel gear	Elevating shaft	Bronze, No. 3	1				18 teeth, 1.257-inch pitch, felt washer.
Do	Elevating intermediate shaft	Cast iron, No. 2	1				22 teeth, 1.257-inch pitch.
Elevating buffer springs	Elevation slide nut	Steel	2				
Elevating gear cover	Bolted to rear transom	Cast iron	1				
Elevating connecting shaft gear cover.	Elevating connecting shaft gears	do					Elevating slow-motion gear.
Elevating handwheel shaft gear cover.	Elevating handwheel shaft gears	do					Do.
Elevating connecting shaft bracket (front).	Bolted to chassis	Cast iron, No. 1					Do.
Elevating connecting shaft bracket (rear).	do	do.					Do.
Elevating handwheel	Slow-motion elevating handwheel shaft	Bronze, No. 1					Do.
Elevating connecting shaft gear.	On elevating handwheel shaft	Cast iron, No. 1					Do.
Do	On connecting shaft	Bronze, No. 2					Do.
Elevating handwheel shaft gear.	do	Cast iron, No. 1					Do.
Do	On handwheel shaft	Forged steel, No. 2					Do.
Elevating connecting shaft	In brackets	Forged steel, No. 1					Do.
Elevating handwheel shaft	Elevating connecting shaft bracket (rear)	do					Do.
Elevating clutch	Elevating connecting shaft	Steel					Do.

Elevating gibs	Bolted to rear transom	Cast steel, No. 1	2				
Elevating handwheel	Elevating shaft	Wrought iron	2				Cast-iron hub.
Elevating intermediate shaft	Through bearing on rear transom	Steel	1				2 keys, tapper pin, and nut.
Elevating pin	Through elevating arm and slide	Forged steel, No. 3	1				
Elevating screw	Through elevating slide and nut	Steel, No. 3	1	3.75	68.35		⅓ inch pitch, 3⅓-inch lead L. H., 2 keys.
Elevating shaft	Through chassis	Steel	1				5 collars, 3 keys, 2 split pins.
Elevating slide	Between gibs (rear transom)	Cast steel, No. 1	1				
Elevating slide nut	Elevating slide	Bronze, No. 3	1				2 bolts, 2 pins, 2 steel springs.
Elevating slide stop	Rear transom	Forged steel	1				Nut and pin.
Elevating spur gear	Elevating screw	Cast iron, No. 2	1				38 teeth, 15.2-inch pitch diameter.
Elevating spur pinion	Elevating intermediate shaft	Bronze, No. 3	1				12 teeth, 4.8-inch pitch diameter.
Elevating friction washer	Under elevating gear	Bronze	1	8.5			
Elevation disk bracket	Bolted to chassis	Cast iron, No. 1	1				
Elevation disk spiral spring	Fastened to hub and bracket	Steel	1				
Elevation disk hub	Elevation disk shaft	Bronze, No. 3	1				
Elevation disk shaft	Elevation disk bracket	Forged steel, No. 1	1				
Elevation disk gear	Elevation disk shaft	Cast iron, No. 1	1				
Elevation disk	Elevation disk hub	Alluminum Alloy	1				
Elevation disk gear bracket	On rear transom	Cast steel	1				
Elevation disk rack	On elevating slide	Cast iron, No. 1	1				
Elevation pointer	Elevation pointer bracket	Bronze	1				
Elevation pointer bracket	Bolted to chassis	Cast iron, No. 1	1				
Elevation pointer dowel	Elevation pointer	Steel	1				
Elevating and retracting controller direction plate and pointer.	Elevating and retracting controller	Bronze	1				
Elevating and retracting motor bracket.	Bolted to chassis	Cast steel	1				
Elevating and retracting motor gear.	Retracting crank shaft	Cast steel, No. 2	1				124 teeth, 0.7854 pitch.
Elevating and retracting motor pinion.	Motor shaft	Steel	1				14 teeth, 0.7854 pitch.
Elevating and retracting motor idler gear.	Idler shaft	Bronze, No. 3	1				31 teeth, 0.7854 pitch.
Elevating and retracting motor idler shaft.	Maneuver lever	Steel	1				With nut.
Emptying coupling	Top carriage	Bronze	1				
Do	do	Bronze, No. 4	1				
Emptying coupling plug	Emptying coupling	do	1				
Equalizing and throttling pipes.	Top carriage	Steel and copper	7				Different lengths.
Equalizing and throttling pipe connections.	Pipes and top carriage		14				Steel rings and bronze followers.
Equalizing and throttling pipe straps.	Top carriage	Wrought iron	4				
Eye screw	Gun lever and top carriage caps	Forged steel	4				
Elevating pointer	Rear transom	Brass	1				
Elevating scale	Bolted to slide	Bronze	1				
Elevating direction plates	Elevating gear	do	4				

NAMES OF THE PARTS, WITH THEIR LOCATION, AND THE MATERIAL OF WHICH THEY ARE MADE—Continued.

Name of part.	Location.	Material.	No.	Diameter or width.	Length.	Nuts.	Remarks.
Filling and vent tubes	Cylinders, top carriage	Steel	4				Copper gasket.
Filling and vent tube plugs	Filling and vent tubes	Bronze	4	1	1.25		
Filling plug instruction plate	Top carriage	do	2				
Firing pistol bracket	Bolted to sight standard	do	1				
Follower	Rear cylinder head and stuffing box	do	4				
Friction disk	Traversing intermediate bevel gear	Cast iron, No. 1	3	15			
Friction ring	do	Bronze	1				
Fish plates	Distance rings	Wrought iron	4				
Fillers	Between buffer plates	Balata	20				
Front brackets	For sight	Cast steel, No. 1	2				
Guard chain	Sighting platform	Steel	1				
Gland	On follower	Forged steel	4				In halves.
Graduation strips	Crosshead	Bronze	2				
Grease cups	Gun lever axle and gun levers	do	6				
Grease-cup covers	Grease cups	do	6				
Grease-cup pistons	do	do	6				Nut and pin.
Grease cup piston springs	On piston	Steel	6				
Grease cup piston washers	Screwed to piston	Bronze	6				Leather washer and screw.
Gun lever	Carrying gun	Cast steel, No. 1	2				
Gun lever axle	Gun lever	Forged steel, No. 3	1				
Gun lever yoke	do	Cast steel, No. 1	1				
Gun lever axle caps		Cast steel, No. 2	2				
Gland	On throttling valve	Bronze	1				
Handles for counterweight	Counterweight	Forged steel	72				Cast in tenth layer of weights.
Hand screw; sight standard	Sight standard	do	2				
Hooks (S)	For lifting counterweights	do	3				
Keys	Racer joints	Steel	2				
Do	Chassis to racer	do	4				
Do	Counterweight	Forged steel, No. 3	2				
Liners	do	Tobin bronze	6				2 wide, 4 narrow.
Ladder-rail connections	Ladders, front and rear	Steel	8				
Ladder (front)	Sighting platforms	do	2				
Ladder (rear)	do	do	2				
Lanyard cam	Elevating arm	Bronze	1				
Lanyard filling piece	Elevating band	do	1				
Lanyard attachment case	Lanyard filling piece	do	1	5.9	1.6		
Lanyard attachment case bolt	Lanyard attachment case to filling piece	Steel	2	.5	1.5		With nut.
Lanyard attachment case cover.	On lanyard attachment case	Bronze	1				
Lanyard attachment pawl	On pawl pin	Steel	1				
Lanyard attachment pawl spring.	Lanyard attachment case and pawl	do	1	.3	1.1		Wire 0.04 diameter.
Lanyard attachment pawl pin	In lanyard attachment case	do	1	.25	1.35		
Lanyard attachment reel	do	Bronze	1				

Lanyard attachment spring	do	Steel	1				0.025 thick, 18 feet 6 inches long.
Lanyard attachment spring shaft.	do	do	1	.62		1	1.06 flats.
Lanyard guide	Near breech of gun	Bronze	1				
Lanyard guide screw	Lanyard guide to gun	Steel	2	.312($\frac{5}{16}$)	.68		
Lanyard extension	Lanyard attachment and guide		1				Italian hemp cord, 35 feet long.
Liner	Top-carriage cylinders	Cast iron, No. 1	2				
Leveling wedges	On platform under base ring	Forged steel	24				4 have pins.
Leveling wedge shoe	do	Cast iron, No. 2	24				
Leveling wedge covers	do	Sheet iron	24				
Liners	On piston	Bronze	8				
Do	Base ring slide	do					
Lining	Top-carriage cylinders	Cast iron, No. 1	2				
Ladder standard	Chassis (right)	Cast steel	1				
Latch	Throttling valve	Bronze	1				
Left corner post	Sighting platform	Steel	1				
Liners, alternate	Elevating gear	Tobin bronze	2				
Manhole cover	On inside platform	Steel plate	1				
Manhole cover handle	Manhole cover	Forged steel	1				
Maneuver lever	Elevating and retracting motor	Cast steel	1				With collar and bronze bushings.
Do	Retracting motor	do	1				
Maneuver lever arc	Bolted to chassis	Cast iron	1				
Maneuver lever arc stud	Maneuver lever arc	Steel	2			2	
Maneuver lever lock bolt	Maneuver lever	do	1				With chain.
Maneuver lever oil tube	do	Steel and brass	1				
Name plate	Top carriage	Bronze	1				2 brass screws.
Observation hole covers	Racer	Steel plate	2				
Oil plugs	For all oil holes	Bronze	113		.5		16 extra.
Outside platform brackets	Supporting outside platform	Cast steel, No. 1	17				
Outside platform braces	do	Wrought iron	1				
Pins	Leveling wedges	Steel	4				
Platform bracket	For sight standard	Cast steel, No. 1	1				
Pawl	Pawl casing	Forged steel, No. 3	2				
Pawl-buffer blocks	Pawl journal	Bronze, No. 4	2				
Pawl-buffer springs	Pawl-buffer block	Steel	12				
Pawl lever	Front of carriage	Cast steel, No. 2	2				
Pawl springs	Pawl	Steel	2				
Pinch bars	Top carriage into battery	Forged steel	2				
Pit ladder	In counterweight well	do	1				
Piston-rod brackets	Bolted to chassis	Cast iron, No. 2	2			4	Male buffer, forged solid with rod.
Piston and rod	Top-carriage cylinders	Forged steel, No. 3	2				
Piston-head liners	Piston head	Bronze	8				
Platform (inside)	Racer	Steel plate	2				In 10 sections.
Platform (outside)	On brackets, bolted to racer	do	1				
Plates	On buffer	Wrought iron	18				
Piston-rod bracket	For piston rod (left)	Cast steel	1				
Do	For piston rod (right)	do	1				
Pipe connections	Throttling valve		10				

NAMES OF THE PARTS, WITH THEIR LOCATION, AND THE MATERIAL OF WHICH THEY ARE MADE—Continued.

Name of part.	Location.	Material.	No.	Diameter or width.	Length.	Nuts.	Remarks.
Retracting gear clutch	Retracting drum shaft	Steel	1				
Retracting drum gear collar	do	Bronze, No. 2	1				
Retracting clutch spring	do	Steel	1				
Retracting clutch spring seat	do	Cast iron	1				
Retracting third pinion	Retracting crank shaft	Bronze, No. 3	1				11 teeth, 2.513-inch pitch.
Retracting clutch shipper rod	In shipper fork bracket	Steel	1				
Retracting clutch shipper fork	On retracting clutch	Wrought iron	1				
Retracting clutch shipper fork bracket.	Bolted to left chassis	Cast iron, No. 2	1				
Retracting shipper rod handle	Shipper rod	Bronze	1				
Retracting ratchet wheel	Retracting crank shaft	Forged steel	1				
Retracting rope	Clamped to retracting drums	Steel	2	0.75			37 feet long.
Retracting rope clamp	Bolted to drum	Forged steel	4				8 bolts.
Retracting rope loop	Retracting rope	do	2				24 pins.
Retracting rope sheave	Buffer bracket	Cast iron, No. 2	2				
Retracting rope trough	Bolted to carriage	Steel plate	2				
Retracting speed crank	Retracting crank shaft	Forged steel	2				
Retracting trough angle	Buffer bracket	Wrought iron	2				
Retracting trough bracket	Rear transom	Cast iron	2				
Retracting trough support	Chassis	do	2				
Retracting motor bracket (outer).	Bolted to chassis	Cast steel	1				With bronze bushing.
Retracting motor bracket (inner).	do	do	1				Do.
Rheostat cover	Rheostat	Sheet steel	1				
Retracting brake lever	Retracting brake band	Steel	1				
Retracting brake band	Retracting drum	do	1				
Retracting brake handle	In retracting lever	Forged steel	1				
Retracting crank and drum shaft bearings.	In chassis	do	4				
Retracting motor gear	Retracting crank shaft	Cast steel, No. 2	1				124 teeth, 0.7854-inch pitch.
Retracting motor idler gear	Idler shaft	Bronze, No. 3	1				35 teeth, 0.7854-inch pitch.
Retracting motor pinion	Retracting motor shaft	Steel	1				14 teeth, 0.7854-inch pitch.
Retracting motor idler shaft	Maneuver lever	do	1				With nut.
Retracting cranks	Retracting crank shaft	Forged steel	2				With brass sleeve.
Retracting crank shaft	Through chassis	Forged steel, No. 2	1				4 keys, 1 collar, 1 taper pin, 1 set screw.
Retracting drum	Drum shaft	Cast iron, No. 2	2				
Retracting drum gear	do	do	1				
Retracting drum shaft	Through chassis	Forged steel, No. 2	1				3 collars, 6 keys, 2 taper pins, 1 set screw.
Retracting gear	On second pinion drum shaft	Cast iron, No. 2	1				90 teeth, 1.257-inch pitch.
Do	On third pinion drum shaft	do	1				64 teeth, 1.875-inch pitch.

Retracting first pinion	Retracting-crank shaft	Bronze, No. 3	1				22 teeth, 1.257-inch pitch.
Retracting second pinion	Retracting-drum shaft	do	1				20 teeth, 1.676-inch pitch.
Roller bearing	Retracting second pinion	Steel	1				
Do	Retracting third pinion	do	2				
Do	Retracting-drum shaft	do	2				
Do	Retracting-chain sheave	do	2				
Do	Retracting-crank shaft	do	2				
Do	Elevating shaft	do	2				
Do	Elevating pinion shaft	do	2				
Do	Elevation shaft	do	1				
Do	Traversing intermediate shaft	do	2				
Do	Traversing crank shaft	do	2				
Do	Traversing pinion shaft	do	1				
Ratchet	Motor gear	Forged steel	1				
Roller bearing	Elevating shaft	Steel	2				
Do	Intermediate shaft	do	2				
Do	Elevating shaft	do	1				
Do	Elevating screw (split bushing)	do	1	4.25	5.5		
Racer	On traversing rollers	Cast steel, No. 1	1				
Recoil rollers	On chassis	Forged steel, No. 3	26				2 with large holes.
Rods	Counterweight	do	4				
Ratchet pawl fulcrum		Steel	2				
Ratchet pawls		do	2				
Roller cages	On chassis	Cast steel	2				
Retracting direction plates	Retracting gear	Bronze	2				
Roller axles	Traversing rollers	Forged steel	26				
Right corner post	Sighting platform	Steel	1				
Sighting platform bracket	Bolted to left standard	Cast steel, No. 1	1				
Standard, left	Bolted to racer	do	1				
Standard, right	do	do	1				
Standard brackets	Standards to chassis	do	2				
Sight standard	Left standard	Cast steel, No. 2	1				
Safety latch	On latch fulcrum	Forged steel	2				
Safety-latch dog	Crosshead	do	2				
Safety-latch fulcrum	Front transom	Steel	2				
Safety-latch stop	Driven into chassis	do	2				
Safety firing switch slip base	Bolted to top carriage	Cast iron	1				
Safety firing switch lever base	Bolted to left chassis	do	1				
Sight holder shoe	Sight standard	Forged steel	2				
Sight standard	Piston-rod bracket	Cast steel	1				
Sight standard caps	Sight standard	Forged steel	2				
Screws, countersunk	Observation cover	Bronze	32	.75	1		
Do	Platform plate	do	190	.75	1		
Do	Azimuth circle	do	60	1.5	1.125		
Do	Filling-plug instruction plates	do	8	.25	.5		
Do	Graduation strips	do	14	.25	.5		
Do	Direction plates	do	26	.25	.5		
Do	Index to slide nut	Brass	1	.25	.7		
Do	Lid to azimuth-pointer holes	Bronze	5	.5	1.125		
Staples	Counterweight	Forged steel	43				
Sight-arm pin	Sight standard	Bronze	2				

NAMES OF THE PARTS, WITH THEIR LOCATION, AND THE MATERIAL OF WHICH THEY ARE MADE—Continued.

Name of part.	Location.	Material.	No.	Diameter or width.	Length.	Nuts.	Remarks.
Screws, hexagonal	Collars, retracting and drum shaft	Wrought iron	2	0.875	2		Set screw.
Do	Elevating pin	do	1	2	4		Do.
Sheave pins	Through buffer bracket and sheave	Forged steel, No. 2	2				2 tap bolts.
Sight-elevating slide	Guides on standard	Bronze	1				1 bronze washer.
Sight-elevating screw	In sight-elevating slide	Forged steel, No. 3	1				1 2-inch nut and 0.5 x 1 set screw.
Sighting platform (left)	Left side of carriage	Steel	1				
Sighting platform (right)	Right side of carriage	do	1				
Sighting platform railing	Sighting platform	Wrought iron					1-inch wrought-iron pipe, different lengths.
Sighting platform, top and bottom connections.	do	Steel	37				17 bottom, 20 top.
Separators	For distance rings	Cast iron, No. 1	22				
Stuffing-box follower	Front and rear stuffing boxes	Bronze	4				
Stuffing-box head	Top carriage cylinder	Cast steel, No. 2	2				
Stuffing-box gland	Front and rear stuffing boxes	Forged steel	4				
Screen	Sighting platform	Steel	1				
Screen connection	do	do	1				
Sighting platform	Right side of carriage	Forged steel	1				On some carriage.
Shipper fork	Slow-motion elevating clutch	Steel					Elevating slow-motion gear
Shipper-fork guide	Connecting shaft bracket	do					Do.
Standard cover	Bolted to left standard	Cast iron	1				With 1 piece 0.125 gas pipe.
Staples	Counterweights	Forged steel	43				
Stuffing-box bushing	Cylinder head	Bronze	2				
Stuffing box (front)	Front end of top carriage cylinder	do	2				
Stuffing box (rear)	Rear end of top carriage cylinder	Bronze and steel	2				
Suspension rods	Suspended from crosshead	Forged steel, No. 3	4				
Starting rheostat bracket	Bolted to chassis		1				2.5 x 3.5 x 0.375 angle.
Traversing roller axles	Through distance ring and rollers	Forged steel	24				
Throttling valve	Top carriage	Bronze, No. 3	1				
Throttling-valve gland	Body of valve	Bronze	1				
Throttling-valve latch	do	do	1				
Throttling-valve padlock	Yoke of valve	do	1				
Throttling-valve seat	Body of valve	Steel	1				
Throttling-valve stem	Valve yoke	Bronze	1				
Throttling-valve yoke	Body of valve	do	1				
Throttling-valve tubes	Recoil cylinder top carriage	Steel	2				
Throttling-valve straps		Wrought iron	2				
Traversing direction plates	Traversing gear	Bronze	2				
Traversing connecting shaft gear cover.	Over traversing connecting shaft gears	Cast iron					Right hand slow-motion gear.
Traversing handwheel shaft gear cover.	Over traversing handwheel shaft gears	do					Do.
Traversing clutch lever	On left sighting platform	Steel					Do.

Traversing clutch fulcrum	do	Cast iron					Do.
Traversing clutch fulcrum pin	Traversing clutch fulcrum	Steel					Do.
Traversing clutch lever foot piece.	Traversing clutch lever	do					Do.
Traversing clutch lever foot piece pin.	Traversing clutch foot piece	do					Do.
Traversing clutch connection	Over traversing connecting shaft	Steel tubing					Do.
Traversing clutch spring	In traversing clutch connection	Steel					Do.
Traversing clutch connection collar.	End of traversing clutch connection	Bronze					Do.
Traversing connecting shaft gear.	Traversing crank shaft	Cast iron, No. 1					Do.
Do	Traversing connecting shaft	Bronze					Do.
Traversing handwheel shaft gear.	do	Cast iron, No. 1					Do.
Do	Traversing handwheel shaft	Forged steel, No. 2					Do.
Traversing handwheel	do	Bronze					Do.
Traversing handwheel shaft bracket.	Bolted to left standard	Cast iron, No. 1					Do.
Traversing connecting shaft bracket.	Bolted to left chassis	do					Do.
Traversing handwheel shaft	Traversing handwheel shaft bracket	Steel					Do.
Traversing connecting shaft	Left side of carriage	do					Do.
Traversing clutch	Clutch connection	do					Do.
Traversing clutch collar	Traversing connecting shaft gear	do					Do.
Traversing clutch cover	Traversing clutch	Bronze					Do.
Top and bottom connections	For railings on sighting platform	Steel	37				
Telescopic sight	Left sighting platform		1				
Telautograph bracket (upper)	Bolted to piston-rod bracket and chassis	Cast steel	1				
Telautograph bracket (lower)	Bolted to chassis	do	1				
Telautograph springs	Between telautograph and brackets	Steel	3				
Telephone bracket	Bolted to left standard	Cast steel	1				
Thrust plates	Under base ring	Steel	12	4.25	11		
Throttling-valve gland	Body of valve	Bronze	1				
Throttling-valve yoke	do	do	1				
Throttling-valve latch	do	do	1				
Throttling-valve padlock	Yoke of valve	do	1				
Throttling-valve stem	Valve yoke	do	1				
Throttling-valve body	Top carriage	Forged steel	1				
Throttling valve	Throttling valve stem	Steel	1				
Throttling tubes	Recoil cylinders, top carriage	Forged steel	2				
Throttling bar	do	do	4				
Top carriage	On recoil rollers	Cast steel, No. 2	1				
Tool hooks	Chassis	Wrought iron	12				
Transom (front)	Bolted to chassis	Cast steel, No. 1	1				
Transom (rear)	do	do	1				
Transom cap	Rear transom	do	1				
Traversing bevel gear	Traversing intermediate shaft	Cast iron, No. 2	2				45 teeth, 1.257-inch pitch.
Traversing bevel pinion	Traversing shaft	Bronze	1				15 teeth, 1.257-inch pitch.
Traversing bracket	Bolted to chassis	Cast steel	1				
Traversing crank	Traversing shaft	Forged steel	2				

NAMES OF THE PARTS, WITH THEIR LOCATION, AND THE MATERIAL OF WHICH THEY ARE MADE—Continued.

Name of part.	Location.	Material.	No.	Diameter or width.	Length.	Nuts.	Remarks.
Traversing intermediate bevel gear.	Traversing pinion shaft	Steel	2				46 teeth, 1.571-inch pitch, taper pin.
Traversing intermediate bevel pinion.	Traversing intermediate shaft	Bronze	1				14 teeth, 1.571-inch pitch.
Traversing intermediate bracket.	Bolted to chassis	Cast iron, No. 2	2				Different shapes, one of each.
Traversing intermediate shaft.	Through traversing intermediate brackets	Forged steel, No. 2	1				2 collars, 2 taper pins.
Traversing pinion	Traversing pinion shaft	Bronze, No. 3	1				14 teeth, 2.094-inch pitch.
Traversing pinion bearing	Racer	Cast steel, No. 1	1				
Traversing pinion shaft	Through traversing bracket and bearing	Forged steel, No. 2	1				2 collars, 3 taper pins, key.
Traversing rack	Bolted to base ring	Forged steel	1				234 teeth, 2.094-inch pitch.
Traversing rack screw	Traversing rack to base ring	Wrought iron	39	0.875	2.75		
Traversing rollers	On base ring	Forged steel, No. 3	24				
Traversing shaft	Through chassis	Steel	1				2 collars, 2 taper pins, 2 keys.
Traversing stops	Bolted to base ring	do	2				
Tripping crank	Tripping shaft	Forged steel	2				
Tripping crank pins	Through crank and pawl levers	Forged steel, No. 3	2				2 collars, 2 rollers, 2 pins, 2 nuts.
Tripping lever	Tripping shaft	Forged steel	2				
Tripping lever buffer	Bolted to racer	do	2				
Tripping lever shaft	Through chassis	do	1				
Washer, ball bearing	Elevating screw	Steel hardened	2				Top and bottom parts.
Yoke	On throttling valve	Bronze	1				
Valve seat and stem	Throttling valve	Brass	1				
Connections	For railing on sighting platform	Steel					

AMMUNITION TRUCKS (THREE PER CARRIAGE).

Name of part.	Location.	Material.	No.	Diameter or width.	Length.	Nuts.	Remarks.
Arm	Riveted to frame	Steel	2				
Axle	For ammunition truck	Forged steel, No. 2	1				2 washers, 2 nuts, 2 split pins, 1 taper pin.
Bevel gear	Elevating screw	Cast iron, No. 2	1				20 teeth, 5.714-inch pitch diameter.
Bevel pinion	Elevating crank	Bronze	1				10 teeth, 2.857-inch pitch diameter.
Bracket	For shot tray	do	1				
Brake lever	Brake shaft	Steel	1				
Brake-lever spring	Brake lever	do	1				
Brake shaft	Through brake-shaft bracket	do	1				1 key, 2 taper pins.
Brake-shaft bracket	Bolted to frame	do	2				2 bolts.
Bushings	For caster and truck wheels	Bronze	3				

Brake shoe	Brake shaft	Cast steel	2				
Cartridge pan	On pan support (frame)	Steel	2				
Caster	Caster bracket	Cast steel, No. 3	1				Collar and taper pin.
Caster bracket	Riveted to frame	Bronze	1				
Caster wheel	For ammunition truck (caster)	Cast steel	1				Rubber tire.
Caster-wheel pin	Through caster and wheel	Forged steel	1				Split pin.
Crank	For elevating the shot tray	do	1				Collar, key, and taper pin.
Elevating screw	Inside of plunger	do	1				Threads, 3 per inch, left-hand.
Frame	For ammunition truck	Steel	1				
Handle	Through arms	Ash	1				2 pins riveted at both ends.
Nut	Riveted to plunger (inside)	Bronze	1				
Oil plugs	For all oil holes	do		0.5			
Plunger	Inside of plunger sleeve	Wrought-iron pipe	1				
Plunger sleeve	Outside of plunger	Bronze	1				
Shot tray	Bracket for tray	Forged steel	1				
Step bracket	Bolted to sleeve	Bronze	1				
Stepwasher	Step bracket	Forged steel hardened	1				
Stop	Shot tray	Steel	1				
Stop piece	Plunger sleeve	do	1				
Stop support	Shot tray	Wrought iron	1				
Tipping arm	Riveted to plunger	Cast iron					
Shot-tray end	On tray	Flanged steel	1				
Collar	On bracket	Forged steel	1				
Do	On crank	do	1				
Tipping bolt and nut	Handwheel	do	1				Nut and slip pin.
Tipping handwheel	Tipping arm	Bronze	1				
Tipping nut	do	Steel	1				
Tipping nut trunnions	Tipping nut	Bronze	2				2 taper pins.
Tray support	Shot tray	do	1				
Truck wheel	On axle	Cast steel	2				Rubber tires.
Shot-tray end	On tray	Flanged steel	1				
Collar	On bracket	do	1				
Do	On crank	do	1				

SHOT TONGS (SEVEN PER CARRIAGE).

Center pin		Steel	1				
Dog	Center pin	do	1				
Inner claw		do	1				3 separators.
Outer claw		do	1				2 separators.
Shackle	Outer claw	do	1				
Shackle pin	do	do	1				

ELECTRIC FIRING, LIGHTING, AND POWER.

Name of part.	Location.	Material.	No.	Diameter or width.	Length.	Nuts.	Remarks.
Angle irons	Supporting 3-inch conduit	Steel	2		88		
Battery	In battery box		1	2.375	5.562($5\frac{9}{16}$) or 6.125		Made up of 6 No. 4 O. K. dry cells or Columbia, connected in series.
Cell connection	Between battery cells		5				No. 14, B. & S. wire.
Lug	On cell and terminal connection	Copper	12				
Terminal connection	Battery to connection		2				Do.
Battery box	On bracket on outside platform	Oak	1				
Battery box connection	On battery box	Bronze	1				
Bolts	Battery box and bracket	Steel	2	.5	8.25		2 nuts.
Hasp and hook	On battery box	Brass	4	.875	2.875		
Nipple	In battery box connection	Bronze	2	.75	.75		
Bolts, tap	Shade T5M	Steel	3	.5	1		
Do	Hooks T28Z	do	2	.5	1		
Do	Elbow T28E	do	1	.5	1.5		
Do	Strap T28N	do	1	.5	1		
Do	Strap T28W	do	6	.5	1		
Do	Strap T28V	do	2	.5	1		
Do	3 x 2.5 x 0.5 inch angle	do	4	1	2		
Do	Strap T28X	do	1	.5	1		
Do	Junction box covers	do	8	.5	.875		
Bolts, tap screw	Strap T28Y	Brass	2	.25	.5		Round head.
Bolts, tap	Strap T4M	Steel	1	.375	.75		
Do	Strap T28T	do	2	.75	1.25		
Do	Bracket T5H	do	1	.5	1		
Do	Strap T28S	do	2	.75	1.5		
Do	Strap T28U	do	6	.5	1		
Bolts, tap P45K	For straps P45Q, P45R, P45S	do	30	.5	1		
Bolts, tap	Rheostat cover to communicating switch and rheostat bracket.	do	12	.375	.75		
Do	Strap T12Z	do	1	.5	1		
Bolts, through	Communicating switch and rheostat bracket to chassis	do	4	1.25	5.25		4 nuts.
Do	3-inch elbow to angles	do	4	.75	2.25		Do.
Bushings V23AM	Conduit to portable lamp	Cast iron	1				0.75 x 0.5.
Bushings V23AN (outlet insulator).	0.5-inch conduit	do	5	.5			Porcelain lined. See Bulletin No. 5, page 18. H. Krantz Manufacturing Co.
Bushings V23CN (outlet insulator).	1.5-inch conduit	do	1	1.5			Do.
Bushings V23DN (outlet insulator).	2-inch conduit	do	1	2			Do.
Bushings V23BN (outlet insulator).	1.25-inch conduit	do	1	1.25			Do.

Bracket T5H	Supports lamp fitting at elevation disk	Wrought iron	1				
Coupling E12U			3				
Cap E12S			1				
Connection T28E	For 0.5 pipe	Cast iron	1				
Candelabra lamp E12NA			3				
Cap E12S	On lamp fitting	Bronze	1				
Candelabra receptacle	0.8-candlepower lamps		3				125 volts, $\frac{1}{4}$ ampere.
Coupling V23AA	0.5 conduit		9	.5			Right and left.
Coupling V23BA	0.75 short nipple V23BT to 0.75 conduit		1	.75			Do.
Coupling V23CA	1.25 conduit		2	1.25			Do.
Coupling, chase V23HA	Junction box T4J		1	.5			Western Electric Co., No. 5064.
Circuit breaker	In circuit breaker box		2				1 for elevating and retracting, 1 for traversing.
Circuit breaker spring	Circuit breaker	Steel	1	.058			
Elevating and retracting motor.	Inside carriage on bracket		1				Shunt wound, 4 to 8 horsepower.
Elbow T28R	3-inch conduit	Cast iron	1				
Elbow T28E	Near azimuth pointer lamp	do	1				
Electric lamp spring E12Q	At 8-candlepower lamps	Steel	3	.054			
Elevating and retracting controller.	On controller standard		1				General Electric Co.'s type R-28-J.
Elbow V23AJ	Conduit to portable lamp		1	.5			
Fitting V5NI	For 3 pipe and hose	Bronze	1				
Firing circuit, branch of	On left side of carriage and gun		5				No. 14 B. & S. standard wire, with flexible conduit 0.25-inch inside diameter.
Bolt, tap	For straps P45Q, P45R, and P45S	Steel	33	.5	1		
Contact-fork connection	Firing-circuit, terminal and connection to primer	Copper	1		1.625		
Bushings	In swivels and nipples	Hard rubber	12		1.156(1$\frac{5}{32}$)		
Nut	On swivel on flexible conduit	Bronze	10	.875	.5		Forming part of terminal.
Plug	In firing circuit terminals	do	10		.975		
Receptacle	do	do	9	.28	1.125		
Sleeve	On ends of 0.25 flexible conduit	do	10				
Socket	In bushings of firing-circuit branches and battery-box connections.	do	12	.33	.75		
Strap P45Q	On gun and carriage	Steel	27				
Strap P45R	On gun	do	1				
Strap P45S	On gun and carriage	do	2				
Swivel	On ends of 0.25-inch flexible conduit	Bronze	10	.62	1.75		
Washer	In terminals and battery-box connection	Hard rubber	12	.46	.062($\frac{1}{16}$)		
Firing pistol	On firing-pistol bracket, on sight standard		1				
Bolt, tap	1-inch magnet header for spiral to buzzer board	Brass	2	.093($\frac{3}{32}$)	.375		
Binding bolt	In spring insulation	do	1				With 4 nuts, chamfered on both sides.
Binding post	On buzzer board	do	1		.687($\frac{11}{16}$)		With set screw, connected with binding stud.
Do	do	do	1	.5			With split and connecting with spiral.
Binding post screw	Binding post to buzzer board	Steel	2	.125	.562($\frac{9}{16}$)		
Binding screw	In binding post in contact with buzzer	Brass	1	.125	.218($\frac{7}{32}$)		To hold connecting wire from binding stud.

ELECTRIC FIRING, LIGHTING, AND POWER—Continued.

Name of part.	Location.	Material.	No.	Diameter or width.	Length.	Nuts.	Remarks.
Firing pistol—Continued.							
Binding stud	Molded in spring insulation	Brass	1				With platinized point, for contact with trigger spring.
Bushing	In nipples in pistol cover	Hard rubber	2	0.75			Slotted to match nipple.
Button gland	In pistol frame on push-button stem	Brass	1				Knurled end.
Buzzer	On buzzer frame	Magnet iron and brass	1				
Buzzer board	On pistol cover	Molded mica	1	2.5	2.656($2\frac{21}{32}$)		
Buzzer board nut	Molded in buzzer board	Brass	2				
Buzzer board screw	Buzzer board to pistol cover	do	2	.187($\frac{3}{16}$)	.406($\frac{13}{32}$)		Thread 25 long.
Buzzer frame	On buzzer board and magnet poles	do	1				
Buzzer frame bolt	Buzzer frame to magnet header	do	1	.125	1.531($1\frac{17}{32}$)		Countersunk head.
Buzzer frame screw	Buzzer frame to buzzer board	Steel	1	.187($\frac{3}{16}$)	.484($\frac{31}{64}$)		
Buzzer pivot	In buzzer frame	do	2	.093($\frac{3}{32}$)	.312($\frac{5}{16}$)		
Filler piece	Under retaining catch on pistol cover	do	1	.5	.125		
Contact screw	In binding post	do	2	.125	.359($\frac{23}{64}$)		With platinum tip 0.031($\frac{1}{32}$).
Header screw	Magnet header to buzzer board	do	2	.187($\frac{3}{16}$)	.593($\frac{19}{32}$)		
Magnet bar	On magnet header	Magnet iron	2	.281($\frac{9}{32}$)	1.546($1\frac{35}{64}$)		
Magnet header	On buzzer board	Soft iron	1	.75	1.484(1—)		
Magnet screw	Magnet bars to magnet header	Steel	2	.140($\frac{9}{64}$)	.531($\frac{17}{32}$)		
Magnet spool	On magnet bars	Hard rubber	2		1.468($1\frac{15}{32}$)		20 layers of silk-covered copper wire on each spool.
Nipple	In pistol cover, under binding bolt and binding stud	Bronze	2	.75	.75		One end slotted for screwdriver.
Pistol bolt	Pistol frame to pistol cover	Brass	2	.25	.25		20 threads per inch, U. S. standard; head knurled.
Pistol cover	On firing pistol bracket	Bronze	1				Supporting part of firing pistol.
Pistol frame	On pistol cover	do	1				Housing and handle of firing pistol.
Push-button spring	In pistol frame on push-button stem	Brass	1				6 coils, 0.187($\frac{3}{16}$) solid height.
Push button	In pistol frame	do	1				With vulcanized fiber tip.
Retaining catch	On pistol cover	Steel	1				Tempered.
Resistance spool	In buzzer board	Hard rubber	1	.687($\frac{11}{16}$)	.25		Wound with 72 inches of German silver wire.
Spiral screw	Spiral to spiral screw nut molded in buzzer board	Brass	1	.125	.406($\frac{13}{32}$)		
Spiral screw nut	Molded in buzzer board	do	1				
Spool wood screw	Resistance spool to buzzer board	do	1	.125	.437($\frac{7}{16}$)		Countersunk head.
Spring insulation	On pistol cover	Molded mica	1	1.5	2.75		
Spring insulation screw	Spring insulation to pistol cover	Brass	2	.25	.468($\frac{15}{32}$)		
Trigger	In pistol frame	Bronze	1				
Trigger pivot	In trigger and pistol frame	Brass	1	.25	.937($\frac{15}{16}$)		Thread 0.32 long.

Trigger spring	On spring insulation	do.	1				Held down by binding bolt.
Washer	On binding bolt in spring insulation	Micanite	1	.640($\frac{41}{64}$)	1.234($1\frac{15}{64}$)		
Ground connection	Near breech od gun	Steel	1				Connected with branch of firing circuit.
Hose, flexible metallic (V5AT)	From terminal box to conduit on carriage	do.	1	.3	11.25		Coupling on each end.
Hooks T28Z	0.75 conduit to rear transom	do.	2				
Hook E14C	Fastened to left rear transom. See 14-4-14		1				
Junction box T4J	0.75 and 0.5 conduit		1				
Junction box rear T28C	On 2 and 3 conduit	Cast iron	1				
Junction box middle T28B	3 conduit	do.	1				
Junction box V23EY							
Lamp	At throttling valve, elevation disk, and azimuth pointer.		3				8 candlepower, 110 volts.
Lamp	Center and sides of carriage		3				Edison base, 16 candlepower, 110 volts.
Lamp fitting E12R	At 8-candlepower lamp	Cast iron	1				
Lamp candelabra E12NA			3				
Lamp E9H	For sights		2				
Lamp fitting E12R	Azimuth pointer	Cast iron	1				
Lamp, portable, E14A	Connected to plug box		1				
Nipple for terminal box V18E	Terminal box fitting	Bronze	1				
Nipple chase V23AW	Junction box T4J		1	.5			Western Electric Co., No. 5055.
Nipple 0.5 close V23LT	0.5 conduits and junction boxes		6	.5			Wrought iron, insulation lined.
Nipple 0.75 short V23BT	Junction box, T4J and 0.75 coupling		1	.75			Do.
Nipple 1.25 short V23CT	Signal corps outlet box		2	1.25			Wrought iron, insulation lined, R. and L.
Nut	On lamp fitting J and reflector E12P	Bronze	3				
Nut E12T		do.	5				
Outlet box	Rear of left chassis		1				Furnished by Signal Corps.
Plug V23B	Four-way tee V23AD and tee V23BC		2	.75			
Plug V23F	Four-way tee T28P		1	2			
Plug V23G	3 elbow T28A		1	3			
Plug V23E	Four-way tee V23BD		2	1.5			
Plug box E14B	R. and L. chassis		2				
Portable lamp E14A	See 14-4-14		1				
Plug box E14B	See 14-4-14		2				
Racer insulating tube T5P	In racer	Hard rubber	1				
Reflector E12P	Over 8-candlepower lamps	Steel	3				
Retracting motor	Inside carriage, on bracket		1				Shunt wound, 4 to 8 horsepower.
Rheostat cover	Rheostat	Sheet steel					
Receptable candelabra E13AJ	Azimuth pointer, elevation disk	Vulcanized	5				
	Buffer valve and sights	Asbestos					
Screws	Shade T5L	Steel	3	.375	1		
Screws, round head	Strap T28Y	Brass	2	.25	.5		
Shade T5L	Over 16-candlepower lamps	Flanged steel	1				
Shade T5M	do.	do.	2				

ELECTRIC FIRING, LIGHTING, AND POWER—Continued.

Name of part.	Location.	Material.	No.	Diameter or width.	Length.	Nuts.	Remarks.
Switch E13Q			1				
Socket holder E13AG	R. and L. chassis and transom lights	Bronze	8				For 16-candlepower lamps.
Socket E13AH	Azimuth pointer, elevation disk, buffer valve, and sights.	do	5				
Switch water-tight E13B	On chassis		2				8-candlepower lamps.
Safety firing switch	On left side of carriage		1				
Blade	In front end of lever	Hard copper	2	1.5	2.5		
Block	Front end of lever on clip base	Vulcanized rubber or molded mica.					
Bolt tap	Lever base to chassis	Steel	3	.75	2		Thread 1.25 long.
Do	Clip base to lug on top carriage	do	2	.75	2.5		Thread 0.75 long.
Do	Covers to stop and clip base	do	6	.375	.5		Heads 0.5.
Bushing	In lever	Bronze	1		2		
Do	On blades and clip blocks in lever and clip base	Vulcanized rubber or molded mica.	4				
Clip	In clip blocks	Hard rubber	4				2 right, 2 left.
Clip block	In end of clip base	Hard copper	2				
Cover	On stop	Sheet steel	1	3	7.625		
Do	On clip base	do	1	3.5	7.812(7$\frac{13}{16}$)		Other end flared.
Lever	On lever base	Cast iron	1				
Lever base	On left chassis	do	1				
Lever pivot	In lever and lever base	Steel	1	.75	3.75		Thread, 1 long.
Nut	On terminal attachment	do	8	.25			Chamfered both sides, 2.5-inch tap, 24 threads per inch.
Do	On shanks of blades and clip blocks	do	4		.375		0.5 tap, 13 threads per inch.
Pin	Stop to lever base	do	2	.25	1.875		Both ends riveted.
Do	Blocks on lever and clip base	do	2	.25	.437($\frac{7}{16}$)		Driven.
Pin, split	In shanks of blades and clip blocks	do	4	.125	1		
Spring cover	On lever	Spring steel	1				No. 1 standard.
Stop	On lever base	Cast iron	1				
Taper pin	Lever pivot and lever base	Steel	1	.25	1.75		
Terminal attachment	On clip base		1				
Do	On lever		1				
Washer	On shanks of blades and clip blocks	Steel	4	1	.062($\frac{1}{16}$)		
Socket E13AF	See 14-4-13		3				
Starting rheostat	Starting rheostat bracket		1				Holtzer-Cabot Electric Co.
Strap T28N	0.5 conduit	Steel	1				
Strap T28T	2 conduit	do	1				
Strap T28S	3 conduit	do	1				
Strap T28X	Supporting 0.5 conduit	do	1				

Strap T4M	Telephone conduit to standard brackets	do	1				
Strap T28Y	Firing circuit to top carriage	do	1				
Strap T28X	do	do	1				
Strap T12Z	1.25 conduit	Steel	1				
Strap T28S	Supporting 3 conduit	do	1				
Strap P45R	See 14-5-45	do	1				
Strap P45Q	See 14-5-45	do	27				
Strap T28W	0.5 conduit to sight standard	do	4				
Strap T28V	1.5 conduit to rear transom	do	1				
Strap T28U	0.5 conduit to chassis	do	5				
Strap P45S		do					
Strap, clamp, and brace for 3. pipe T28F.		do	1				
Tee 0.5	See 14-0-23		1				
Tee four-way T28D	On 2 and 3 conduits	Cast iron	1				
Tee V23BC	0.75 and 0.5 conduits	do	1				0.75x0.75x0.5.
Tee four-way V23BD	1.5 and 0.75 conduits	do					1.5x0.75x1.5—1.5 side outlet.
Tee four-way V23AD	0.75 conduit	do	1				0.75x0.75x0.75—0.5 side outlet.
Tee V23AC	Connects on conduit to portable lamp	do	1				0.5x0.5x0.5 insulation lined.
Terminal box	In counterweight well	do	1	10 10.75	16.5		Large size for 18 terminals.
Base	In terminal box	Slate	1	9.625	15.375		
Bolt	Through terminals and base	Bronze	13	.25	2.125		Thread 1.25 long.
Do	do	do	2	.375	2.25		Thread 1.5 long.
Bolt tap	Engineer Corps, flange to terminal box	Steel	4	.75	1.625		Thread 1 long.
Do	Terminal box to base ring	do	4	.75	1.75		
Cover	On terminal box	Cast iron	1	10	16.5		
Marking plate	On base	Sheet brass	20	.375	.75		
Nut	On 0.25 bolt in base	Bronze	39		.25		Chamfered on both sides.
Do	On 0.375 bolt in base	do	6	.375			Do.
Pin	Marking plate to base	Brass	40	.08	.375		
Plate	On base	Sheet brass	1	.75	15.375		
Screw, round head	Plate on base	Steel	4	.187 ($\frac{3}{16}$)	.375		
Terminal	On base	Copper	4				For No. 6 wire to armature.
Do	do	do	26				For No. 14 wire.
Washer	On 0.25 bolt in base	Bronze	26				
Do	On 0.375 bolt in base	do	4				
Thimbles E12X		Galvanized iron	4				0.06 thick.
Telautograph	Rear of left chassis		1				Furnished by Signal Corps.
Telephone	Bolted to bracket on left standard		1				Do.
Twisted hook E12Y	On carriage and sight	Steel	4				For 2 cables.
Traversing motor	Inside carriage on motor bracket		1				Shunt wound, 4 horsepower.
Traversing controller	Controller standard		1				General Electric Co.'s type P-7-B.
Wire	In conduits from terminal box to motors, circuit breakers, controllers, and rheostats.	Copper	1				No. 6 stranded, rubber covered, and braided.

ELECTRIC FIRING, LIGHTING, AND POWER—Continued.

Name of part.	Location.	Material.	No.	Diameter or width.	Length.	Nuts.	Remarks.
Wire	Terminal box to lamps, starting rheostat to motor	Copper	1				No. 14 stranded, rubber covered, and braided.
Do	In conduits from terminal box to starting rheostat and motor.	do	1				No. 6 stranded, rubber covered, and braided.
Do	In conduits from terminal box to outlet box	do	1				No. 14 stranded, rubber covered, and braided, twisted pair for telephone.
Do	do	do	1				No. 14 stranded, rubber covered, and braided for telautograph.
Do	In conduits from terminal box to lamps and traversing motor.	do	1				No. 14 stranded, rubber covered, and braided.

War Department,
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